Declassified and Approved For Release 2013/04/25 : CIA-RDP80R01426R010300010001-9 A-701
(Conclusions only)
By: R. Adelman

Machavariani, M. Z.

Vliianie gerbitsidov na mikrofloru pochvy.

[Effect of herbicides on soil microflora]

Akademiia Nauk Gruzinskoi SSR. Institut Polevodstva. Trudy, vol. 8, pp:99-107. 1954. 64.9 Ak12

(In Georgian with Russian resume)

p.105-106: RESUME

The Institute of Field Crop Culture of the Academy of Sciences, Gruzinian [Georgian] SSR has studied the action of the herbicide "dinok" upon the activity of diverse physiological groups, such as ammonifyers, nitrifyers, denitrifyers, azotobacter, actinomycetes and fungi.

Our data show that "dinok" stimulates the growth and development of ammonifyers. For instance, the cells found in 1 gr of soil taken from the control test plot in May numbered 10 million, but there were 100 times more of them in 1 gr of soil from the test plot treated with "dinok". In June, there were 10 times more ammonifyers, then on the control test plot.

The action exerted by the "dinok" herbicide upon nitrifying bacteria is somewhat different - at first it depresses the energy of these bacteria, but later on it increases their growth and development. Thus, for instance, 10 days after the application of the herbicide, the amount of nitrifying bacteria was 10 times less than on the control test plot, later on, however, a sharp increase was noted in the activity of these bacteria.

The activity of denitrifying bacteria, however, shows a 10-time increase just as soon as the herbicide is applied.

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Upon azotobacter the given herbicide produces no effect whatever at the beginning, yet afterwards an increase is noted in the development of this microbe.

While the activity of actinomycetes is weakened as a result of "dinok" herbicidal action, no effect whatever is noted on the growth and development of fungi.

Our data prove that herbicides exert the same action on soil microflora as on higher plants.

Some physiological groups increase their activity under the influence of the herbicide "dinok", some cease growing and developing, while some are not at all influenced by the herbicide.

It must also be noted that the positive action of "dinok" manifests itself variously upon the different physiological groups.

Upon some groups the positive action of the given herbicide manifests itself at the beginning of its application, yet upon others it at first exerts a depressive action, but later on manifests its stimulating effect.

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Mel'nikov, N. N., and others.

Khimiia gerbitsidov i stimuliatorov rosta rastenii.

[Chemistry of herbicides and stimulants of plant growth]

Moskva, Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatel'stvo Khimicheskoi Literatury, 1954.
381p. 395 M49

(In Russian)

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Trans. A-703
(In full)
By: V. Makarenko

Manchenkov, I. P.

Navoz i ego primenenie.

[Manure and its utilization]

In Spravochnik agronoma po udobreniiam.
Ed. 2, rev., p.98-129 Moskva, Gosudarstvennoe
Izdatel'stvo Sel'skokhoziaistvennoi Literatury,
1955. 57 C42 Ed. 2.

(In Russian)

A-703

Manure is a mixture of hard and liquid excrements of farm animals and of their litter. The quality of manure depends, to a considerable degree, on the type of animals, on the quality of feed, on the amount and kind of litter, on its physical and chemical properties and on the methods of storing the manure.

Composition of litter and of manure.

Table 31.

Absorbing qualities of litter (from various sources)

Kind of litter	100 parts by weight of dry litter absorb parts of water
Straw of winter rye	300
" " " wheat	170--300
Straw of oats	170--228
" " barley	300
" " spring wheat	170--300
" " winter spelt -	300
" " peas	280
" " clover	250
" " alfalfa	280
" " millet	340
" " buckwheat	280--350
Moss	600--700
Peat meadow (from lowlands)	500--700
" mossy (from highlands)	1000--1500
Leaves of beech	200
" " oak	400
" " white beech	325
" " birch	300

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Table 31 (continued)

Kind of litter	100 parts by weight of dry litter absorb parts of water
Leaves of linden	350
" " aspen	320
[Begin p.99]	
Coniferous needles	150--200
Fir "lapki" [paws]	70
Shavings	300
Sawdust	400--445
Oak bark	400--500
Stalks of Jerusalem artichoke	210--275
Potato haulms	180--220

Table 32.

Average composition of litter (in per cent) (from various sources)

Kind of litter	Water (H_2O)	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Lime (CaO)
Straw of winter wheat	14.0	0.45	0.20	0.9	0.28
" " " rye	14.3	0.45	0.26	1.00	0.29
" " oats	14.3	0.65	0.36	1.60	0.38
" " spring wheat	14.0	0.56	0.20	0.75	0.26
Sedge	14.0	-	0.42	2.00	0.36
Leaves of oak	14.0	0.80	0.34	0.25	2.02
Needles of spruce	-	0.50	0.20	0.08	0.54
" " pine tree	-	0.80	0.10	0.13	0.46
" " balsam fir	-	0.90	0.20	0.13	1.60
Ferns	-	2.40	0.46	2.42	-
Peat meadow	80.0	2.80	0.30	0.20	-
" moss	25.0	1.05	0.10	0.02	0.30
Sawdust	-	0.20	0.30	0.74	1.05

The composition of straw of winter or spring crops fluctuates, depending on the fertility of the soil, on the amount of introduced fertilizers and other conditions (see table 33).

The drier the litter is, the more liquid it can absorb, and the less litter is needed.

Straw cuttings absorb more moisture, than does the whole straw. A

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highly parched lowland peat absorbs liquid very slowly; for this reason its moisture content, when used as litter, should not be less than 30-35%.

The amount of litter depends to a considerable degree on the quality of fodder. When the fodder is watery much more litter is needed.

When in the household there is a great amount of litter material, the doses of litter, shown in table 34, can be (sentence continued after table 34).

T a b l e 33.

The composition of straw of winter rye and oats, depending on the kind and amount of fertilizers, introduced into the soil (in per cent for air-dried materials)

(according to analyses of VIUAA)

Kind and doses of fertilizers	Straw of winter rye			Straw of oats		
	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium K_2O	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium K_2O
Without fertilizers	0.38	0.11	0.63	0.42	0.12	0.86
Manure 20 t/ha	0.44	0.29	0.74	0.61	0.28	0.94
" 40 "	0.60	0.30	0.95	-	-	-
$N_{60}P_{45}K_{45}$	0.52	0.27	0.80	0.70	0.32	1.03
$P_{60}K_{60}$	0.41	0.28	0.860	0.62	0.54	1.18

T a b l e 34.

Amount of litter needed for one head of cattle (kg/day) (from different sources)

Type of animals	Straw of grain crops	Straw of leguminous plants	Dry moss	Lightly decomposed peat moss	Medium decomposed peat	Tree leaves	Sawdust, shavings
Big cattle	3-5	4-6	2-3	5-6	8-10	3-4	3-6
Horses	2-4	3-5	1.5-2	3-4	5-6	2-3	2-4
Sheep	0.5-1	0.5-1	0.25-0.5	-	-	-	-
Pigs:							
sows with young pigs	5-7	6-8	3-4	-	-	-	-
Boars	1.5-3	2-3	1-2	2-3	-	1.5-2	2-3
Those, that are fattened	1-2	1.5-2	0-16	1.5-2	-	1-2	1.5-2
Weanlings	0.5-1	1-1.5	0.8	0.5-1	-	0.5-1	1-1.5

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increased one and a half to two times. Utilisation of straw, peat and other materials as litter is one of the best methods to transform them into valuable organic fertilizers. By increasing the amount of litter one can increase the accumulation of manure one and a half to two times.

Composition of hard and liquid excrements depends not only on the type of animal, but also on the quality of fodder. According to fairly numerous analyses by VIUAA, the composition of the animal urine and of poultry droppings fluctuates considerably depending on the quality and amount of fodder, which is given to the animals (tables 35 and 36).

[Begin p.101].

T a b l e 35.

Composition of hard and liquid excrements of animals (in per cent) (from various sources)

Excrements	Water (H_2O)	Dry matter	Nitrogen (N)	Potassium (K_2O)	Lime (CaO)	Magnesium (MgO)	Phosphoric acid (P_2O_5)	Sulfuric acid (SO_3)
Fresh feces of								
Horses	75.7	24.3	0.44	0.35	0.15	0.12	0.0535	0.06
Big cattle	85.8	16.2	0.29	0.10	0.35	0.13	0.17	0.04
Sheep	65.5	34.5	0.55	0.15	0.46	0.16	0.31	0.14
Pigs	82.0	18.0	0.60	0.26	0.09	0.10	0.41	0.04
Fresh urine								
Horses	90.1	9.9	1.55	1.50	0.45	0.24	0.00	0.06
			0,9-1,2 *					
Big cattle	93.8	6.2	0.68	0.49	0.01	0.04	0.00	0.13
Sheep	87.2	12.8	1.95	2.26	0.16	0.54	0.01	0.30
Pigs	96.7	3.3	0.43	0.83	0.00	0.08	0.07	0.08
Droppings								
Hens	56.0	44.0	1.63	0.85	2.40	0.74	1.54	0.45
Geese	77.1	22.9	0.55	0.95	0.84	0.20	0.54	0.14
Ducks	56.6	43.4	1.00	0.62	1.70	0.35	1.40	0.35
Pigeons	64.9	48.1	1.76	1.00	1.60	0.50	1.78	0.33

* From analyses by VIUAA.

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Table 36.

Limits of fluctuations of the composition of animal urine and of poultry droppings, depending on the amount and quality of fodder (in per cent).

Form of excrements	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Urine of horses	0.60-1.60	-	0.62-1.80
" " big cattle	0.25-0.95	-	0.21-0.84
Chicken droppings (air-dried)	1.20-5.82	0.6-3.65	0.5-2.94

[Begin p. 102].

The more of the concentrated fodders are introduced into the animals' rations, the more nitrogen and potassium is contained in the animal urine.

Table 37.

Average amount of hard and liquid excrements from various types of animals (according to Periturin)

Type of animals	Hard excrements (kg/day)	Liquid excrements (l/day)
Big cattle	20-30	10-15
Horses	15-20	4-6
Sheep	1.5-2.5	0.6-1.0
Pigs	1.2-2.5	2.5-4.5

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Table 37 a

Composition of fresh manure (in per cent) from analyses of NIU, VIUAA, and other sources)

Component parts	Manure from straw litter					Manure from peat litter	
	mixed	horses	big cattle	sheep	pigs	horses	big cattle
Water	75.0	71.3	77.3	64.6	72.4	67.0	77.5
Organic matter	21.0	25.4	20.3	31.8	25.0	-	-
Nitrogen (N) general	0.50	0.58	0.45	0.83	0.45	0.80	0.60
Nitrogen - protein	0.31	0.35	0.28	-	-	0.48	0.38
" - ammonium	0.15	0.19	0.14	-	0.20	0.28	0.18
Phosphorus (P_2O_5)	0.25	0.28	0.23	0.23	0.19	0.25	0.22
Potassium (K_2O)	0.60	0.63	0.50	0.67	0.60	0.53	0.48
Lime (CaO)	0.35	0.21	0.40	0.33	0.18	0.44	0.45
Magnesia (MgO)	0.16	0.14	0.11	0.18	0.09	-	-
Sulfuric acid (SO_3)	0.10	0.07	0.06	0.15	0.08	-	-
Chlorine (Cl)	-	0.04	0.10	0.37	0.17	-	-
Silicic acid (SiO_2)	-	1.77	0.85	1.47	1.08	-	-
Ferric and aluminum oxide (R_2O_3)	-	0.11	0.05	0.24	0.07	-	-

In its content of nutrients for plants, the horse and sheep manures are much richer than the large cattle's or the pigs. [Begin p.103]

The amount and quality of litter greatly influences the content of nutrients in manure: the peat manure is much richer in nitrogen, than the usual straw manure. The biggest influence on the composition of manure is produced by the quality of the fodder. The more nitrogen, phosphorus, potassium and other elements are contained in the fodders, the richer isthe manure.

Table 38

Fluctuations in the composition of fresh manure, depending on the quality of fodders (in per cent) (from VIUAA analyses).

Component parts	Manure		
	Horse's	Cow's	Pigs
Nitrogen (N)	0.32-0.84	0.21-0.76	0.28-1.05
Phosphorus (P_2O_5)	0.18-0.68	0.11-0.65	0.15-0.73
Potassium (K_2O)	0.28-0.80	0.19-0.76	0.22-0.85

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Table 39.

Composition of horse manure, depending on the degree of its decomposition (in per cent) (from analyses by NIU and VIUAA)

Component parts	Fresh manure	After 2 months of storage	After 4 months of storage	After 6-8 months of storage
Water	72:0	75:6	74:0	68:0
Organic substances	24:6	19:5	18:0	17:5
Nitrogen (N) total	0:52	0:60	0:66	0:75
" protein	0:38	0:45	0:54	0:68
" ammonium	0:15	0:12	0:10	0:05
Phosphorus (P_2O_5)	0:31	0:38	0:43	0:48
Potassium (K_2O)	0.60	0.64	0.72	0.84

Annotation. The changes in the composition of manure from other types of animals, depending on the time of its storage, proceed approximately in the same ratio.

The composition of manure changes greatly depending on conditions and length of its storage. Under conditions, where losses of manure's nutritive substances by means of leaching out by rain or thawed waters were excluded, the following dependence has been firmly established: the longer the manure is kept, and, consequently, the fuller degree of decomposition it reaches, the higher becomes the percentage content of nitrogen, phosphorus, potassium and of other elements, but the lower becomes the content of ammonium nitrate (see table 39). Only in a [Begin p.104] manure with high straw content, which is semi-decomposed, can there be less ammonia, than in a fully decomposed one.

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Table 40.

Average losses of nitrogen and of organic substances from manure, depending on the length of its storage (in per cent from the initial content of nitrogen and of organic substances in manure) (from VIUAA data)

Losses	After 2 months of storage	After 4 months of storage	After 6-8 months of storage
Total nitrogen	20-25	30-35	45-50
Organic matter	25-30	35-40	50-60

Total losses of nitrogen and of organic matter in manure increase during its longer storage (and, consequently, with intensification in its decomposition).

However, as the losses of organic matter from the mean in the composition of manure during its storage usually exceed the losses of nitrogen, with a longer storage of manure, and with an increase in its decomposition, as a rule, there occurs a rise in the percentage content of nitrogen in manure in the presence of considerable losses of the manure's total amount of nitrogen.

Losses of total content of nitrogen during the storage of manure are the lower, the smaller was the content of nitrogen in the fresh, initial manure. And vice versa, the richer was the fresh manure in nitrogen (the more nitrogen becomes lost, and thus will the percentage content of nitrogen in manure grow slower during storage time.

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Table 41.

Losses of nitrogen during a 4-months storage of manure, depending on the amount of nitrogen whichwas present in the fresh manure (according to VIUAA data).

Manure from straw litter		Manure from peat litter		Manure from woody litter (sawdust)	
Contents of nitrogen in fresh manure (in %)	Losses of nitrogen (in % of the initial content of nitrogen in manure)	Contents of nitrogen in fresh manure (in %)	Losses of nitrogen (in % of the initial content of nitrogen in manure)	Contents of nitrogen in fresh manure (in %)	Losses of nitrogen (in % of the initial content of nitrogen in manure)
0.62	43.9	0.85	25.2	0.54	38.4
0.48	35.5	0.75	18.8	0.42	24.8
0.40	31.2	0.60	13.7	-	-
0.32	12.4	0.40	8.4	-	-

[Begin p.105]

The higher is the dose of litter, the more manure is obtained and the smaller will be the losses in nitrogen during storage.

A peat litter helps in a sharp decrease of losses in nitrogen from manure, compared to straw or woody litter, although in a peat manure, as a rule, there is more nitrogen, than in manures prepared from other kinds of litter.

Influence of storage conditions on manure's quality.

It is established, that the speed of decomposition of organic matter is in close dependence on the conditions of moistening, of temperature and of aeration of manure. The most vigorous decomposition of manure happens when its moisture content is at 55 to 80%. With the lowering or an increase in moisture beyond these limits the speed of manure's decomposition is retarded. Aeration produces an especially great influence on the tempo of decomposition of manure. The easier, and in a greater quantity, does

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oxygen of the air enter the stock pile of manure, the more vigorously, and at a higher temperature, does the manure decompose. Aeration, and, consequently, the temperature also, are regulated by the volume of the stock pile of manure, as well as by a degree of its packing and moistening during the decomposition of manure under practical conditions.

Various methods of manure's storage are produced in practice, by a special procedure of stacking it up in a pile. The,so-called, hot storage of manure is achieved by a loose piling of manure in narrow piles, not wider than 2-3 m.

The anaerobic, or, so-called, cold storage of manure is achieved by heavy packing of a sufficiently moist manure, piled into a stack not less than 3-4 m in width and 1.5-2 m in height.

The third, so-called, hot-pressed method of manure storage is achieved with a loose piling of manure in layers 80-100 cm thick, with a subsequent immediate heavy pressing down of each layer, when temperature of manure reaches 50-60°. When using this method, not less than 3 or 4 layers of manure are put in, so that an overall height of the stack, after packing, would reach at least 1.5-2 m (see table 42).

With the cold method of storage there is several times less of loss of nitrogen and of organic matter, compared to other methods of manure storage. Besides this, during the cold method of storage, nitrogen remains in a more active form and is more accessible to the plants (see table 43).

During cold method of manure storage there is a smaller accumulation of manure water, than with any other method. In tests by NIU for each 10 tons of fresh manure during 4 months of storage there was an accumulation of manure water: with the cold method - 170 L; with the hot-pressed - 460 L, and with the loose - 1000 L.

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According to field experiments, conducted by NIU, by VIUAA, and other experimental institutions, with the introduction of differently prepared manures under potatoes, winter rye and spring grain crops, the highest increases in yields were obtained with the cold (solid) method of manure's storage (see table 44). [Begin p.106]

T a b l e 42.

Composition of manure (in per cent) during different methods of storage in the course of 4 months (according to NIU analysis).

Component parts	Manure from straw litter			Manure from peat litter		
	Method of storage					
	Cold	Hot-pressed	Loose	Cold	Hot-pressed	Loose
Water	75.7	77.7	77.9	77.8	79.5	80.0
Nitrogen (N) total	0.61	0.66	0.71	0.62	0.67	0.65
" " protein	0.37	0.60	0.61	0.37	0.44	0.42
Nitrogen N amonium	0.25	0.16	0.18	0.24	0.22	0.18
Phosphorus (P_2O_5)	0.39	0.45	0.48	0.27	0.26	0.31
Potassium (K_2O_5)	0.42	0.48	0.62	0.37	0.48	0.51
Lime (CaO)	0.13	0.24	0.22	0.19	0.24	0.24
Organic matter	21.7	18.7	18.4	20.0	18.0	17.0
Carbon	9.69	8.61	7.51	9.08	8.30	8.00
Cellulose	8.82	6.58	6.47	6.88	5.88	5.72
Pentosans	3.69	2.49	2.48	2.72	2.19	1.68

T a b l e 43.

Average losses (in per cent) of organic matter and of nitrogen during different methods of manure storage for 4 months, an average of 5 tests (according to data of NIU and VIUAA).

Methods of storing manure	Manure on straw litter		Manure on peat litter	
	Losses of organic matter	Losses of nitrogen	Losses of organic matter	Losses of nitrogen
Hot (loose packing)	32.6	31.4	40.0	26.2
Hot-pressed (loose packing with subsequent pressing	24.6	21.6	32.9	16.1
Cold (pressed packing)	12.2	10.7	7.0	1.0

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Considering that, according to all agriculturally valuable properties, both the loose and the hot-pressed methods of manure storage are inferior to the pressed (cold) method, this last one should be adapted as the most efficient method for manure's storage. [illegible]

[Begin p.107].

T a b l e 44.

Influence of various methods of manure's storage on the yield of agricultural crops (in c/ha) (according to data of VIUAA experiments, conducted on podzolic soils of the Central Expetiment Station of VIUAA in Moscow oblast').

Methods of storage of cow's manure and dose per 1 ha.	Winter rye		Potatoes		Oats (after effect of manure after potatoes)	
	Yield of grain	increase in yield	Yield of potato tubers	increase in yield	yield of grain	increase in yield
Loose (19 t)	22.4	3.7	217.6	50.3	24.7	4.3
Hot-pressed (21.8 t)	23.7	6.0	222.0	54.8	25.8	5.4
Cold (26.2 t)	26.5	6.8	256.6	69.4	28.2	7.8

Annotation. The dose of each form of manure per 1 ha, shown in the first column of the table, was obtained from 30 tons of fresh manure.

Hot-pressed method of preparation of manure according to agricultural indicators is more valuable than the loose method, when manure is not pressed down either while it is piled into the stack, or after its heating in the stock pile.

Waiting for a hot period of decomposition to realize and to immediately press down the manure as the temperature in it rises to 60° and higher is recommended in the following cases.

1. When the veterinary surgeon finds it necessary, as a means to control helminthosis or the pathogens of other diseases in animals.

2. When a large amount of straw is used for litters; not less than 5-6 kg a day per each head of cattle or horse.

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3. When a necessity arises to prepare in a short period a well decomposed manure (for instance, for application to spring grain crops - spring wheat, barley, or some other crops).

Arrangement of storage place for manure and the technique of piling manure therein.

Two basic variants exist for the arrangement of storage places - overground and pit. If the soil waters allow it, it is always better to arrange a pit storage place.

During decomposition of manure a large amount of a heavy carbon dioxide is developed, which fills up the pit, and in this way checks the entrance of the air's oxygen into the manure. Carbon dioxide hinders the transformation of ammonia compounds into a volatile state. That is why in a pit storage place the decomposition [Begin p.108] of manure proceeds with smaller losses of nitrogen and of organic matter.

In southern and south-eastern dry regions the pit type of storage places are arranged also because in overground stacks manure dries out very soon, and its proper decomposition and its humification are disrupted.

When choosing the type of manure storage place it is also necessary to atake into consideration which of the types will allow a mechanization of labor-consuming works of piling in and of removing the manure. This consideration often has a decisive meaning. In the pit type of storage place it is much easier to mechanize the piling in of manure into stacks, but it is more difficult to mechanize the loading during removal of manure. The storage places are recommended to be arranged not less than 50 m away from animal quarters in places, which are not inundated by rain or thawed waters.

The size of a manure storage place is determined by the number of cattle, by the height of piling of manure into the storage place, and by the

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number of times manure has to be removed from the storage place.

Table 44. a.

Area of a manure storage place per one head of cattle, when piling manure 1.6 to 2 m high (in m^2)

Number of removals of manure during winter	For big cattle	For horses	For the younger generation of cattle and horses up to 2 years of age	For pigs	For sheep and goats
Single removal	5.0	4.0	3.0	1.5	0.5
Double removal	2.0	1.6	1.25	0.6	0.2

The simplest overground storage place for manure represents a planned area, on the surface of the ground, which is sloping towards a storage tank for manure water. In order to keep the liquid manure from flowing beyond the limits of the storage place, the area is surrounded, with the exception of entrance and of exit, by a low barrier, 10-20 cm in height. The width of the overground storage place should not exceed 10-12 m.

The basic condition, which every type of manure storage place should meet, is a solid, impenetrable bottom; best of all if it is covered either by cement or asphalt.

For 100 head of cattle the width of the pit along the bottom should not exceed 9-10 m, and depth - 1 m.

The earth, which is removed from the pit is piled in an embankment around the manure storage place. The walls of the pit are made at an angle of 45-60°.

The bottom and the walls must be impenetrable. If the ground is clayey and does not contain any lime, then it is enough to tamp the walls and the bottom very well. [Begin p.109] In orther cases kneaded loam is piled in a layer of 20-30 cm and then tamped well. In order to make it more solid the bottom of the manure storage place is covered by stones, by broken or whole bricks, wood, or other suitable material. It would be good also to use the above materials to cover the walls.

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In order to collect the manure water, which accumulates during decomposition of manure, at the sides of the storage place are arranged manure water storage tanks (fig 6 and 7)

Title of ifigure 6. Longitudinal cross section of the manure water tank.

Title of figure 7. A detail of the earth embankment and of the discharge trench.

The holding capacity of that part of the storage tank which lies below the pit's bottom should not be less than 0.5 m^3 per every 100 m^2 of the area of the manure storage pit. The bottom of the pit should have an appropriate slope in the direction from the central passage through the storage pit to the manure water storage tanks.

Around the manure storage pit ditches for rain and thawed waters must be made (fig. 7). [Begin p.110].

Either the pit or the overground manure storage places must be gradually filled with separate stacks of manure, which are not less than 2-3 m in width. The first stack is piled along one of the long sides of the storage place. The second stack, which should be placed closely to the first, should not be started before the first is piled 1.5 to 2 m high, in a pressed state. One should proceed in this manner until the whole storage place, including the central passage is completely filled.

Title of fig. 8. Manure storage place, according to a design by Sel'khozproekt of the Ministry of Agriculture of USSR: A- general view; B- design; C- longitudinal cross section; d- lateral cross section.

With such a manner of filling, less of nitrogen is lost, [Begin p.111] and all the manure in storage is separated according to the length of time that it is stored and, consequently, according to a degree of decomposition.

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The first stack will have the most decomposed manure, the last one - the least decomposed. The cited order of filling allows an efficient utilization of manure, because the most decomposed manure is needed for the spring crop in the crop rotation schedule, and the least decomposed in the fallow.

A fundamental disadvantage of the described type of pit manure storage place is a case that the embankment and the walls of the pit, along the narrow side, do not allow for the pressing to be done by driving a wagon over the manure. [Begin p. 112]

This disadvantage can be easily corrected by widening to the full width of the storage place the entrance and the exit sides (fig 8 and 9).

Title of fig 9. A manure storage place according to a project by VIUAA (scheme). Approved by Ministry of Agriculture USSR.

With such an arrangement of a manure storage place (when an embankment and walls,are absent on the narrow sides of the place) it is not necessary to arrange manure water storage tanks on both sides. In this case a storage tank is arranged on one side with a general slope of the bottom of the manure storage place into its direction. The bottom of the manure water storage tank is made 1 m deeper than the bottom of the manure storage place.

Methods to assist in the accumulation of manure and of improvement of its quality.

Very often kolkhozes and sovkhozes have excess of straw of winter and spring crops. The best method to transform straw into a high-quality organic fertilizer is to utilize it in increased doses for litters.

One can raise a dose of straw up to 8 kg per head a day in stockyards, which are raked, and 10-12 kg where straw is left under the cattle,

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Use of straw in the form of cuttings helps in the retention of nitrogen and increases its effectiveness considerably. [Begin p.113]

T a b l e 45.

Influence of straw litter in a form of cuttings on the quality of manure (according to VIUAA data)

Dose of litter for one cow per day	Losses of nitrogen during 5 months storage of manure (in % of the total content of nitrogen in the initial fresh manure)	Yield of potatoes (in c/ha) from 20 tons/ha of manure	Increase of yield from manure (in c/ha).
6 kg of whole straw	20.6	381.4	80.9
4 " of straw cuttings (length 10 cm)	12.8	514.7	100.2

A second method to utilize a surplus of straw in the preparation of fertilizers is to compost it with manure. For this purpose straw and manure are piled in layers in the manure storage place in an open stack, they are moistened by manure water, or, in its absence, simply by water and are carefully pressed down.

Peat is the most valuable material for an increase in manure's accumulation.

A slightly decomposed top-layer peat, suitable for litter, can be utilized in an amount of 15-20 kg a day per head of big cattle.

Manure, prepared with peat litter, is much more effective compared to manure, prepared with straw litter.

T a b l e 46.

Comparative effectiveness of straw and peat manure with similar doses of its application under potatoes (according to data of NIU and VIUAA; The mean of three experiments).

Kind of manure	Yield of potatoes (in c/ha)	Increase in yield of potatoes from manure (in c/ha)
Straw	286.8	72.6
Peat	290.0	96.8

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A much higher effectiveness of the peat manure compared to the straw is explained by the fact, that peat contains more nitrogen, it absorbs more ammonia, than straw, and the losses of ammonia during storage of peat manure, as well as when applying it into the soil, are smaller than of the straw manure.

Any peat, including the highly decomposed one from the lowlands, is good for absorption of urine of animals in manure gutters, for installation of peat-pressed floors for animals and for composting with manure in manure storage places or in open stacks. [Begin p.114]

When constructing peat-pressed floors for animal stalls they are deepened to 30-50 cm (rarely deeper) and are packed with peat. Straw, dry, partly decomposed peat, or any other litter material is daily spread over the packed peat; manure is removed as usual.

In order to accumulate manure during the summer pasture period, it is recommended to fence in the temporary field stations for cattle and use in them a large quantity of straw, peat, or any other litter material. After cattle has left for another stand, manure must be gathered and piled into well pressed stacks. It is better to do this work after rain, when all the manure is well moistened.

Determination of the amount of manure.

The amount of manure, which is accumulated on the farm depends on the number of heads of cattle on the length of time of their remaining in the stalls, and on the amount of both litter and fodder.

There are several methods to calculate the accumulation of manure.

The first method consists in determing the amount of manure accumulated from one head of cattle, with a later recount for the whole number

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of cattle (table 47.)

The second method (Dussenge) consists in that the amount of manure (H) is determined by multiplying the used amount of feed (k) and litter (P) by 2:

$$H=(K+P).2.$$

The third method (Vol'fa) is based on experiments, according to which about half of the dry substance of fodder is digested by the animals, and the second passes over into manure. Besides this all the dry matter of the litter goes minto manure. As in the fresh manure there is only 1/4 of dry matter and 3/4 of water, then the total amount of manure (H) is four times greater than one half of the dry matter in the fodder ($\frac{K}{2}$), combined with dry litter (P):

$$H=(\frac{K}{2}+P).4.$$

T a b l e 47.

An approximate amount of ripe manure for one head of cattle in tons per year, taking into account the losses during work periods and on pastures (according to data, accepted by Ministry of Agriculture in USSR)

Length of the stall period	Horses	Big cattle	Sheep	Pigs
From 210 to 240 days	6-7	8-9	0.8-0.9	1.5-2.0
" 200 " 220 "	5-6	7-8	0.7-0.8	1.2-1.5
" 180 " 200 "	4-5	6-7	0.6-0.7	1.0-1.2
Less than 180 days	3-4	4-5	0.4-0.5	0.8-1.0

[Begin p.115]

The fourth method (used in France), consists in determining the amount of manure by multiplying the weight of the whole herd by 25. The amount of manure's accumulation per year is obtained by multiplying the mean weight of one head of cattle by the number of heads in the herd and by 25.

The amount of manure in a stack is determined by multiplying the volume of the stack in cubic meters by the weight of 1 m^3 of manure. The

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volume in cubic meters is obtained by multiplying the length of the stack by its width and by its height in meters. Weight of 1 m^3 of fresh manure, without pressing, equals 300-400 kg; in a pressed state - 700 kg; of semi-decomposed - 800 kg and of highly decomposed - 900 kg.

Effectiveness of manure

Table 48.

An overall effect from manure fertilizer in crop rotation

Sources of data	Doses of manure in crop rotation (in t/ha).	Crops in crop rotation		Increase from manure (in c/ha)	Increases by calculation in grain equivalent (in c/ha).
Field experiments of several years' standing of Dolgoprudni experimetn field, Moscow oblast' (6-year data).	56	Winter rye		10.7	10.7
		Oats		6.5	6.5
		Clover hay		6.5	2.6
		Mangel-wurzel		155.5	15.5
		Total		-	34.1
Field experiments of several years' standing of Mironovski Government Selection Station, Ukrainian SSR (8 year data)	30	Perennial grasses (hay)		6.7	2.7
		Sugar beets		71.0	18.0
		Peas		1.7	1.7
		Winter wheat		4.8	4.8
		Total		-	27.2
Field experiments of several years' standing of Bezenkei experimental station, Ukrainian SSR (9 year data)	20	Winter rye		5.7	5.7
		Sugar beets		66.0	16.5
		Oats		1.5	1.5
		Total		-	27.2
Danish field experiments of several years' standing (Askov) (30 years data)	36	Winter rye		6.7	6.7
		Oats		8.1	8.1
		Clover hay		16.8	6.7
		Mangel-wurzel		264.0	26.4
		Total		-	47.9

[Begin p.118]

Each ton of manure, which was introduced into the soil increases the yield of all crops in the crop rotation on the average, approximately, by 1 c/ha when recalculated in grain equivalent.

Effectiveness of manure fertilizing will rise sharply when methods of its application will be improved.

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high effectiveness in all natural zones and on all types of soils of USSR.

T a b l e 49.

Effectiveness of manure in basic natural zones and on various types of soil.

Natural zone and the experiment institution	Soil	Crop	Yield (in c/ha) Without manure	With manure
Non-chernozem zone				
1) according to data of Soligorski agric. exper. sta. on the average for 4 years	Podzolic sandy loam	Winter rye	19.5	28.7
2) According to data of Central exper. sta. VIUAA, on the average from 5 experiments	Podzolic clayey soil	Winter wheat	17.0	26.1
Chernozem zone				
1) According to data of Shatilovski Gov. select. sta., on the average for 2 years	Leached out chernozem	Winter wheat	16.4	21.1
2) Accord. to data of Kozlovski Gov. select. sta. on the average for 7 years	Leached out chernozem	" "	14.5	25.1
3) According to data of Rostovski Gov. select. sta., mean from 7 experiment	Transcaucasian Chernozem	" "	17.6	23.5
South-eastern zone				
1) Data of Agricultural Institute of South-east, without irrigation	Dark chestnut solonets	" "	16.5	21.9
2) Data of Uralski Gov. select. sta., With irrigation, a mean for 3 years	Chestnut solonets	Spring wheat	31.6	37.55

[Begin p.117]

T a b l e 50.

Average increases of yields and aftereffect from manure fertilising in v various soil-geographical zones of the European part of the Union SSR (according to data of experimental institutions)

Soil-geographical zones	20 t of manure per hectare *			30 t of manure per hectare *		
	Effect on the first crop (winter grain crops)	Aftereffect recalculated in grain equivalent		Effect on the first crop (winter grain crops)	Aftereffect recalculated in grain equivalent	
		1st year	2nd year		1st year	2nd year
Podzolic	5.5	5.5	3.5	7.4	5.7	5.8
Chernozem	4.5	4.0	3.2	5.2	5.5	4.6
Dry south-eastern	2.2	3.5	3.0	3.0	4.0	3.8

* Doses of manure are rounded off.

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Effectiveness of manure on the first crop depends on the soil-climatic conditions, and fluctuates in the following manner: in northern and north-western regions of Soviet Union, in the sufficiently moist podzolic zone, manure produces a top-most effect; but moving from northern and north-western regions to the south and south-east into the dry zone the effectiveness of manure gradually diminishes.

An after-effect of manure, compared to its effect on the yield of the first crop, while moving from north-west to south-east is gradually increasing, and in the south-east dry zone often does not yield; and even surpasses the positive action on the first crop.

On heavy clayey soils the positive action of manure on the crops continues for a period of 8, and even 12 years; on light sandy soils it tapers out on 3-4th crop.

Average increases for potatoes from manure, in a dose of 30 t/ha, in regions of podzolic zone fluctuates from 40 to 100 c/ha, in regions of the chernozem zone - from 25 to 70 c/ha (table 51). [Begin p. 118].

T a b l e 51.

Average effectiveness of manure on the first crop in individual geographical regions of Soviet Union (from various sources).

Soil-geographical regions and the experiment institutions	Dose of manure (in t/ha)	Crops	Increases in yield from manure (in c/ha).
Northern regions of podzolic soil (Karelo-Finnish SSR, Arkhangelskaia, Vologodskaia, and other oblast')	40	Spring and winter grain	7-8
North-eastern regions of podzolic zone (Kirovskaia oblast' exper. station, Iaranskoe and other exper. fields)	20-30	Winter grain	6-8
Ural regions of podzolic zone (Permskaia and Mendeleevskaia ex-. stations, Mayskiovskoe, Borovskoe and other exper. fields)	30-40	" "	7-10

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Table 51 (Continued)

Soil-geographical regions and the experiment institutions	Rate of manure (in t/ha)	Crops	Increases in yield from manure (in c/ha)
North-western regions of podzolic zone (Pskovskaia, Leningradskaia exper. stations, Gdovskoe and other exper. fields	30-40	Winter grain	8-10
Western regions of podzolic zone (BSSR, Smolenskaia, Briianskaia, and other oblasti)	20-30	Winter grain and barley	5-7
Central and southern regions of podzolic zone (Moskovskaia, Beloggrodskaia exper. stations, Shuiskoe, Krukovskoe and other exper. fields	20-30	Winter grain	5-7
Northern regions of chernozem zone (Shatilovskaia exper. sta., Orlovskoe, Livenskoe, Kletskoe and other exper. fields	20-30	" "	5-6
Central region of chernozem zone (Voronezhskaia, Tambovskaia, Kamenskaia exper. stations, Koslovskoe, Kursheyskoe and other exper. fields [Begin p.119]	20-30	Winter grains	4-6
Upper Volga regions (Kazanskaia and Spasskaia exper. stations, Kunevskoe, Laishevskoe and other exper. fields)	20-30	" "	3-5
Central Volga regions (Kuibyshevskaia, Bezenchukskaia, Annenskaia and Chishminskaia exper. stations)	20-30	" "	2-3
Lower Volga regions (Saratovskaia, Balashovskaia exper. Stations, Khvalynskoe Vel'skoe and other exper. fields)	15-20	" "	2-5
Northern Caucasus	15-20	" "	2-5
Transcaucasus	20-30	Corn	7-8
		cotton-fibre	5-6
Kazakhstan (L'vovskoe, Barnaulskoe and other exper. fields)	20-30	Winter and spring grains	2-2.5
Central Asia republics (experimental institutions of Central Asia	20-30	Cotton fibre	5-8
Western Siberia (Omskii Grain Institute, Krasnoluk, Tulunskoe and other exper. fields	20-30	Winter and spring grains	4-7
Far Eastern Institute, Amurskaia exp. sta. and other exper. institutions of the Far East	20-30	Winter and spring grains	4-7

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Coefficient of utilization of the nutritive elements * from manure by the plants (see table 52)

Coefficient of utilization by the plants of nitrogen depends on the type of animals, on the percentage content of nitrogen in manure, on the form of litter and on methods of storage of manure, on the dose of manure, on the difference of soils, and on other causes (table 53).

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* This indicator has a conditional meaning. It should not be comprehended in a literal sense. Calculation of the coefficient of utilization (continued on the bottom of page 120) by the plants of nitrogen from manure, as also of any other nutrient, is based upon an assumption, that a plant utilizes nitrogen, in equal amount from the reserve in the soil, be it fertilized by manure or not. It is clear, that under the influence of biological processes, which are conditioned by an introduction of manure into the soil, the available of elements of nutrition, which are contained in the soil, can be changed very sharply. But the value of this indicator consists in that it allows to judge, more or less accurately, about the effectiveness of various methods of application of one and the same kind of fertilizer, about non-utilized possibilities of further increase of effectiveness of one or another type of fertilizer, about a comparative effectiveness of various kinds of fertilizers, and so on. [begin p.120]

Table 52.

Coefficient of utilization of nitrogen from manure by the first crop

[illegible]	[illegible]	[illegible]
[illegible] soil with manure	34.2	41.3
[illegible] from the source of nitrogen, assimilated by the plants from plots, fertilized in an amount equal (in nitrogen) with manure	28.6	28.0

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Table 23.

Coefficient of utilization by the first crop of nitrogen from manure, coming from different types of animals (assimilated nitrogen, in per cent from the amount of nitrogen, which was introduced into the soil with manure) (from various sources).

Sheep manure	Cow manure	Pig manure	Pig manure (with abundant feeding)	Pig manure (with sparse feeding)
33.6	20.8	10.2	23.0	10.2

Spring wheat and other spring grain crops utilize nitrogen well only from manure containing high percentage of nitrogen. Such is the manure, which has reached a high degree of decomposition, or which was assimilated from animals which received a large quantity of concentrates in their feed.

[Begin p.131]

Table 24.

Coefficient of utilization by spring wheat and by potatoes of nitrogen from manure, depending on the percentage content of nitrogen in manure (from data by VIMA)

Contents of nitrogen in manure (in %)	Nitrogen assimilated (in % of its total content in manure) by:	
	spring wheat	potatoes
0.50	26.0	33.0
0.40	10.2	20.0
0.30	4.0	10.6
0.20	0.0	10.6

Manure which is made from straw, which is only slightly decomposed, and is poor in nitrogen, does not increase, but rather decreases the assimilation of nitrogen from the soil by spring wheat.

Potatoes, fodder roots, vegetable, and other crops with longer periods of vegetation, and a more protracted period of utilization of nutrients from the soil, use nitrogen and other elements of nutrition in a much larger amount, than the spring crops do.

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Table 86.

Coefficient of utilization by the first crop of nitrogen from manure, depending on the form of litter and the method of manure storage. (in per cent) (according to VIUA data)

Litter	Method of storing the manure		
	Loose	Not-pressed	Compressed
Straw	26.5	33.6	36.7
Peat	29.9	50.3	58.8

VIUA established through research, that the first crop utilizes the more nitrogen from manure, the more it is accumulated in a form of ammonia during the storage of manure.

Basically, the protein nitrogen acts in the years that follow when manure continues to decompose.

The higher is the percentage content of the total and of ammonia nitrogens, in the manure, the higher becomes the coefficient of its utilization by the plants. Peat litter increases the utilization of nitrogen by the plants compared to the straw litter. [Begin p.128].

Table 88.

Coefficient of utilization by the first crop of nitrogen from manure, depending on the state of decomposition of manure (in per cent) (according to VIUA data).

Indicators of calculation	Degree of manure's decomposition			
	slightly decomposed	semi-decomposed	strongly decomposed	Manure (after many years of decomposition)
Utilization of nitrogen, introduced with manure	7.8	23.4	17.5	4.8
Utilization of nitrogen, in per cent of nitrogen, assimilated by plants from nitro, containing as much nitrogen as manure does	9.8	29.0	21.9	6.0

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Nitrogen from manure, which was stored under anaerobic conditions is utilized by the plants better than nitrogen from manure, which was stored under aerobic conditions. Nitrogen is assimilated to a larger degree from a semi-decomposed manure, than from manure of the same origin, which is less decomposed, or, on the contrary, which is more highly decomposed.

Coefficient of utilization of nitrogen from sheep and horse manure is higher, than from manure of big cattle.

Experimental data about the coefficient of utilization of nitrogen from manure by all crops in the crop rotation during the full time of the manure's action are very limited. Of greatest value in this respect is a Danish test (Askov), during which the utilization of nitrogen from manure for 30 years does not surpass 30% of the total nitrogen, which was introduced with the manure. According to data of vegetative tests by VIUAA, nitrogen from the manure was utilized to 64.8% by four crops.

Table 87.

Coefficient of utilization by the first crop of phosphorus (P_2O_5) and potassium (K_2O) from manure (in per cents) (from VIUAA data)

Phosphorus (P_2O_5)	Potassium (K_2O)
28.3	87.0

[Begin p.123]

The often observed low coefficient of utilization of phosphorus and potassium from manure is explained not by their low availability to the plants, but because the plants cannot use P or K from manure on account of lack of nitrogen or of any other unfavorable conditions.

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Table 58.

Coefficient of utilization of phosphorus and potassium, depending on the dose of manure (in per cent) (according to NIU data)

Phosphorus (P_2O_5)		Potassium (K_2O)	
Single dose	Double dose	Single dose	Double dose
44.6	28.6	67.0	56.5

Basic methods of efficient utilization of manure. Removal of manure into fields during winter. The winter removal of manure into the field for the winter crop (into the fallow) and for the spring crops is widely used for farming and economic reasons. When removing manure into the field in winter it is necessary to pile it in large stacks, 3-4 m wide and 1.5-2 m high, in a well packed state. If the spreading of manure in the field is done by a manure distributor then, according to the dose of the manure's application, the placement of manure stacks must be planned in such a way as to make the best use of the manure distributor, so that it has the least possible amount of empty runs. The size of manure stacks in the field can be increased when manure is introduced into the soil mechanically. If for a manual method of application of manure it is recommended to pile into each stack about 20-40 tons of manure, then, for a mechanized application, 100 tons and more can be piled into each stack, depending on the power of the manure distributor and on the length of the run. In conformity with this, the width of the field stack can also be considerably increased, which will help to prevent losses of nitrogen and lessen the freezing of manure in winter.

In order to eliminate the possibility of freezing of manure in the field stack, it is necessary to organize the winter removal of manure

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in such a way, that the stacks, in their full width and height, be piled in a shortest time possible, namely: stacks of 30-40 tons in 1-2 days.

Sometimes, when using horses for winter removal of manure, it is piled in the field in small heaps. This sharply decreases its fertilising activity. In small heaps, manure weathers very quickly and dries out, the nutritive elements are leached out from it by rain and thawed waters; variegation of the fields is created, which especially negatively influences the yields of winter and spring grain crops. Often this method brings about a delay in the spring cultivation of fields, because the earth under the small heaps, thaws out very slowly. [Begin p.124].

Table 59.

Influence of methods of manure piling in the field, during winter removal, on its fertilising action (according to VIUAA data)

Crop	Yield in (c/ha)			
	Without manure	Manure which was removed in spring and was immediately plowed in	Manure which was removed in winter and stacked before plowing in	
			in large stacks (of 30 tons)	in small heaps
Winter rye	8.6	14.8	14.5	10.7
Potatoes	111.8	198.6	196.2	138.0

During summer removal from the manure storage place or during distribution of manure from field s tacks, it must be immediately broadcast and plowed in.

Table 60.

Fertilising action of manure, depending on the time of its broadcasting on the field (according to data of Ivanovskaia experimental station).

Time of plowing in the manure	Yield of winter rye (in c/ha)
Manure plowed in immediately after removal	30.5
Manure remained in the field in small heaps for one month	20.0
Manure remained broadcast in the field for one month	26.5

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If it is not possible to plow in the manure immediately or in the next five days after tit is removed into the field, it is then better to leave it broadcast, than in small heaps. Almost all of the ammonia nitrogen is lost in the first 3-5 days when it is broadcast, after this the losses of nitrogen are stopped.

When manure is kept in small heaps the losses of manure are larger, than when it is broadcast on the field (table 61).

Time for placement of manure for various crops. Time of introduction of manure depends on the biological peculiarities of agricultural crops and on the degree of decomposition of manure.

For winter crops the manure, as a rule, is introduced during the raising of fallow. In the regions of non-chernozem zone manure is introduced as during the raising of fallow, so also during its plowing over. When deepening of the plowed layer is done during raising of the fallow, it is better to introduce manure during the plowing over (sentence continued on p.125, after table 61) [Begin p.125]

Table 61

Fertilising action of manure, depending on the period of time of manure's remaining in broadcast form (according to VIUAA data)

Time of plowing in of manure after its broadcasting	Relative yield (in %)
Immediate plowing in	100
After 24 hours	88
" 4 days (24 hour periods)	74
Without manure	52

(a two). In cases of introduction of manure under the two of a fallow it is recommended to use a sufficiently decomposed manure.

The best time for introduction of manure under spring crops is under the autumn plowing. Only on very light, sandy soils it is not recommended to introduce manure in autumn on account of large losses of nitri-

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tive elements from manure by their leaching into the lower layers of soil.

Manure must be very well decomposed for its spring introduction under spring crops.

Often, under the influence of straw manure, the contents of nitrogen, which can be assimilated by the plants decrease instead of being increased. This is explained by the fact, that the non-decomposed organic matter of manure helps in a rapid development of some types of soil microorganisms, for the feeding of which there is not enough of dissolvable forms of nitrogen in the manure, and they start using nitrogen, which is produced in the soil itself.

The time, in the course of which the process of assimilation of nitrogen by microorganisms proceeds vigorously, depends on the chemical composition and on a degree of decomposition of manure: the smaller is the content of nitrogen in the manure, and the more there is of non-decomposed straw, the longer it takes for the positive action of manure to come through. Sometimes this period takes 2-3 months, but more often it fluctuates in the limits of 2-6 weeks.

Taking into consideration the above mentioned reasons, one should apply the most decomposed manure under spring grain crops (spring wheat, barley and others), and then under potatoes, sugar beets, fodder roots, and other plants, which need cultivation. The least decomposed manure should be used under winter crops with an early plowing of it in during the raising of fallow (table 62).

Doses for application of manure depend basically on the soil-climatic conditions and on the fertilized crop. In the north, with a cold and moist climate, higher doses of manure are used, than in the south and the dry south-east. On podzolic and on poor soils it is necessary to

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apply manure in larger amounts, than on chernozem and on highly cultivated soils.

From among all the agricultural plants, the winter and spring grain crops, require lesser doses of manure, when other conditions are alike than potatoes, sugar beets, hemp, and other technical crops. [Begin p.126]

T a b l e 62.

The fertilising action of manure, depending on the degree of its decomposition (according VIUAA data and from other sources).

Degree of manure's decomposition	Increases in yields (in % of increases through semi-decomposed manure)		
	spring grains	potatoes	winter grains
Medium (semi-decomposed manure) in spring application	100	100	100
in autumn "	100	100	-
Weak (slightly decomposed manure) in spring application	45	66	95
" autumn "	98	102	-
Streng (highly decomposed manure) in spring application	115	85	74

The highest doses of manure are used for fodder root plants, silo and vegetable crops (cucumbers, cabbage and others). (In

T a b l e 63.

Yield of agricultural crops (in c/ha) depending on doses of manure.

Crop and region	Doses of manure (in t/ha)								
	0	0	9	18	27	36	54	60	75	90
Winter rye (Moscow oblast')	9.0	-	14.0	16.0	18.5	—	-	-	-
Winter rye (Gorkovskaia oblast')	16.5	18.1	21.2	22.0	25.7	-	-	-	-
" " (Kharkov oblast')	17.3	20.6	21.6	25.5	23.4	-	-	-	-
Potatoes (Moscow oblast')	165	-	225	-	2264	286	-	294	-
" (Irkutsk oblast')	-	-	93	-	138	161	-	-	-
Hemp (straw) (Chernigovskaia oblast')	50	-	56	-	41.7	-	46.6	-	-
Cabbage (podzolic zone)	263	-	-	-	556*	-	552	-	-
Cabbage (Central Asia)	108	-	-	-	135	-	-	217	-
Cucumbers (podzolic zone)	78	-	-	-	150*	-	170	-	218

* 50 t/ha of manure [Begin p.127]

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As the doses of manure are increased, the yields of most all agricultural plants, as a rule, are continuously rising, and only at very high doses (100-150 t/ha) there is no increase in yield seen, and under certain circumstances there is even a decrease.

The increase in yields tapers off the fastest for grain crops with an increase in manure doses. An increase of manure doses for grain crops which is above 20-30 t/ha gives a comparatively low increase in yields.

Although for other crops the increase in yields from higher manure doses does not taper off so fast, as for grain crops, the returns for each ton of manure by an increase in yield becomes lower as a rule (see tables 64 and 65).

T a b l e 64

Remuneration of manure by an increase in yields of winter rye, depending on manure doses.

Indicators of calculation	From data of experiment institutions of Moscow oblast' for podzolic soils			From data of Kharkov exper. station for chernozem		
	Doses of manure (in t/ha)					
	18	27	36	10	20	40
Increases in yields from a full dose of manure (in c/ha)	5.6	6.4	6.6	4.1	5.5	8.0
Increases in yields from one tone of the introduced manure (in kg)	31.1	23.7	18.0	41.1	26.5	13.5

A full remuneration for manure can be calculated only when counting also its aftereffect in crop rotation; the pay for higher doses of manure in that case can be appreciably increased compared with their remuneration only during the first year of action.

The pay for a unit of manure, which was introduced into the soil, depends not only on the dose, but also on the method of introduction of manure.

According to data of field experiments by VIUAA, the increases in the

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yield of potatoes which occur from introduction of manure, and from methods of its introduction, are shown in table 65.

A local introduction of manure (into a furrow, or a hill) under potatoes, highly increases the effectiveness of manure during the first year of its action.

Vast experimental material on doses and on methods of application of manure under various crops allows to make the following conclusion: when there is a shortage of manure on the farm, it is wiser to use it in smaller doses, but on a larger areas, than in larger doses and on a smaller area. Poor, very depleted soils, can be exceptions to this; (sentence continues after table 65) [Begin p.126].

Table 65.

Remuneration of manure by increses in yields of potatoes, depending on the doses of manure

Indicators of calculation	According to data of experiment institutions of Moscow oblast' for podsolic soils				According to data of Moscovskoi experim. station for chernozem			
	Doses of manure (in t/ha)							
	18	36	54	72	20	40	60	80
Increases in yields from the full dose of manure (in c/ha)	60	99	121	129	108	165	203	209
Increases in yields per one ton of introduced manure (in kg)	333	275	224	179	540	412	338	261

Tthey may need larger doses of manure for their faster improvement.

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T a b l e 66.

Remuneration of manure by increase of potato yields, depending on methods of manure's application.

Doses and methods of manure's application	Clayey soil (Central Exper. station VIUAA)		Sandy loam (Sudogodskoé experm. field of VIUAA)	
	increase from the full dose of manure (in c/ha)	increase per 1 ton of manure (in kg)	increase from the full dose of manure (in c/ha)	increase per 1 ton of manure (in kg)
Manure 40 t/ha, continuous application	69.5	174	144.8	361
Manure 20 t/ha, continuous application	47.6	238	112.7	563
Manure 20 t/ha into the furrow	75.4	377	143.1	715
" 10 " " " "	45.5	455	91.8	918
" 5 " " the hill	25.8	516	77.0	1540

When evaluating the influence of various doses of manure, it is necessary to take into consideration its action not only on the first crop, but also the extent of its action on the yield of the following crops (after-effect). A greater aftereffect [Begin p.129] in all soil-climatic zones of the Soviet Union is noted from higher doses of manure.

T a b l e 67.

Sum total of yield increases (according to data of Kharkov oblastnoi experiment station).

Crop	Doses of manure (in t/ha	Increases of yields (in c/ha)
Spring wheat and barley - second and third crops after the winter rye, fertilised by manure	0	1.7
	18	4.2
	36	8.8
	54	10.2

When introducing manure systematically in crop rotation, the difference between the action on the yield of small and of big doses of manure, in one rotation after another, is increasing because of the stronger action of large doses of manure. This is seen, for instance, from the following data of Novosybkovskoi experiment station.

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Table 68.

Comparative effectiveness of various doses of manure in its systematic introduction in crop rotation (according to data of Novosybkovskoi experimental agricultural station).

Doses of manure (in t/ha)	Increases in yield of winter rye (in c/ha)		
	I rotation	II rotation	III rotation
18	4.4	7.4	7.7
36	6.0	9.2	11.6
Difference in yield increases	1.6	1.8	3.9

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A-704
(In Full)
By: V. Makarenko

Rabotnov, T. A.

Primenenie gerbitsidov na senokosakh i pastbishchakh.

[Utilization of herbicides on meadows and pastures]

Zemledelie, vol. 4, no. 1, pp.80-85, Jan. 1956. 20 Z44

(In Russian)

A 704

Large amounts of grasses which are of little value as fodder for animals, and sometimes even are harmful and poisonous plants, grow on natural forage grounds. A predominant amount of meadow weeds are perennials, which are well adapted and are hard to eradicate.

A high choking up of meadows and of pastures is usually the result of their irrational utilization and lack of care for them. That is why the most important method for the control of weeds on natural forage grounds must be a rational utilization of pastures (corral pasturing with mowing down of all plants that remained uneaten, rotation of pastures), and of meadows (keeping them from being denuded of all the grasses in spring observing proper times for mowing, rotations of hay harvests); also use of other measures of care (applying fertilizers, and so on). Other methods of weed control can give a positive long-lasting result only in that case when they are used in conjunction with rational utilization and care for meadows and pastures.

One must also have in mind, that on natural meadows and pastures, side by side with total weeds (poisonous and harmful plants, parasites, plants which are not eaten up by cattle and others) there is a large number of conditional weeds. Many of them are admissible and even desirable in small

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numbers on meadows and pastures, because they have large amounts of protein, of mineral substances, including microelements, as well as have good tasting qualities, act as anthelmintics, and so on. Many varieties of meadow grasses belong to these types of plants. Whereas the total weeds must be fully destroyed, the control of many of the conditional weeds should not include their total destruction. The value of hay and of pasture fodder will be higher if the stand of grass, consisting of valuable grains and leguminous, will contain a small amount of varied grasses, which are eaten by cattle.

In recent years, in order to work out labor-saving, effective methods of weed control, chemical substances (herbicides) are being utilized very widely. Among them phenoxyacetic acids (2,4 D, 2 M - 4 X) are highly effective and easy to use. These herbicides do not damage the grain grasses, but act destructively on many kinds of weed varieties. On the basis of results of tests conducted in USSR and in some countries of Western [Begin p.81] Europe, it is possible to recommend the use of 2,4D for the control of thistles - Cirsium oleraceum Scop, C. lanceolatum Scop, C. palustre Scop, pink thistle, sneezewort, yarrow, mugwort (Artenisia vulgaris), common wormwood, Sonchus arvensis L., goat's beard (Tragopogon pratensis L.), dandelion (Taraxacum officinale Wigg.), hawkweed (Hieracium piloselle L.), shepherd's rod, cornflower (Centaurea pratensis Thuill.), ragweed (Senecio Jacobaea L.), Leontodon biscutellifolius DC., Cousinia Cass., crowfoot (Ranunculus repens L.), buttercup (Ramunculus acris), R. auricomus L., pilewort, wind flower (Anemone nemorosa L.), Ceratocephalus Moench ("cherryk, uchma"), aconites (Aconitum L.), Barbarasa Beck, Bunias orientalis L., Cardamine pratensis L., plantains (Plantago media L., P. major L., P. lanceolata L.), eyebright, yellow rattle, veronica (Veronica longifolia L.), cinquefoil (Potentilla reptans L.) goosefoot, spiraea, sorrels (Rumex acetosa, R. thyrsiflorus Fing., R. crispus L.,

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R. confertus Willd., R. domesticus Hartm. R. obtusifolius L., stork's bill (Geranium pratense L., G. silvaticum L.), poison hemlock (Conium maculatum L.), water hemlock, Libanotis Crantz, angelica (Archangelica officinalis Hoffm.), St. John wort (Hypericum perforatum), willow-herb, Succisa pratensis Moench., Campanula glomerata L., bindweed (Calystegia sepium R.), bedstraw (Galium rubioides L.) and some others.

Of the phenoxyacetic acid compounds, the sodium salt 2.4D is the most used in USSR. In the control of weeds on meadows and pastures of great importance also can be sodium salt of 2M-4X, as well as esters and amino salts of 2.4D and of 2m-4X (according to experiments by T.V. Zosimovskaia in Dedinovski experiment station, of the All-Union Institute of Fodders, and data of many foreign experiments). Esters and amino salts of 2.4D and 2M-4X are usually more effective, than sodium salts of these acids. On meadows and pastures, the compounds 2.4D and 2M-4X are used in solutions of water or diesel oil either as an independent measure, or in conjunction with other methods of weed control and measures for the improvement of forage lands. One can employ either a continuous or a selective spraying on the vegetation.

For a continuous spraying 2.4D and 2M-4X are usually taken in a dose of 0.8-1.6 kg per ha of the active ingredient in 600-1000 L of water; and for aerial spraying 150-300 L of water. Treatment of the stand of grass by herbicide solutions should be conducted during steady, warm (temperature above 16°), dry and windless weather. During a strong wind and, especially, if a rain falls very soon after spraying, the action of 2.4D is lowered. Effectiveness of herbicides on meadows grows if they are used together with wetting agents OP7 and OP10. The continuous spraying can be mechanized, and airplanes are often used for this purpose.

As a result of different reactions of individual varieties of plants

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to the herbicide, great changes are produced in the composition of the meadow's stand of grass. 2.4D affects highly many varieties of grasses. Some varieties become practically wiped out from the stand of grass after sprayings with 2.4D. The weight of grass diminishes from 2 to 4 times. This creates conditions favorable for the growth of grain grasses, which are not harmed by spraying.

2.4D is injurious not only to various grasses but also to leguminous. One should take this into consideration when using chemicals on meadows. By proper use of herbicides it is possible to minimize their harmfulness to the legumes. In those stands of grass, where the legumes are more or less plentiful, herbicides must be used during such times of the vegetative season, or in those years, when the legumes are poorly developed and are protected from the influence of herbicides by the leaves of other plants, which are more luxuriously developed. [Begin p.82]

Development of legumes, and expecially of clovers on meadows, is subjected to sharp changes according to the years. The "clover" years recur periodically; at that time clovers are very abundant and even predominate in the stand of grass. Spraying the grasses with herbicides in such years will lead to a sharp reduction in the content of leguminous plants in the stand of grass, in their yield and in a deterioration of the quality of fodder. Spraying during the "interclover" years does not produce any material influence on clover. Thus, spraying with 2.4D during a "non-clover" year, 1950, which was conducted on the meadows of Dedinovskii experimental station of the Institute of Fodders (lowlands of river Oka), influenced clover only weakly during the year of utilization of the herbicide, and did not lower their yield in the following year, which was favorable for the growth and development of clovers; and even, in some cases, lead to an increase of their yield.

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Effectiveness of herbicides is defined to a considerable degree by the doses and the time of their utilization. From among the doses 0.5, 0.75 and 1 kg per ha, which were tested on Dedinovskii experimental station 1 kg of the active ingredient of 2.4D proved to be the best. The most effective spraying is in spring, when various weeds are either in a rosette-leaf, or in a booting stage. Spraying the aftergrowth gives a lesser effect. Spraying during the phase of blooming and later on lowers the effectiveness of herbicides very sharply. On meadows which are choke full of crowfoot, or of sorrel (R. confertus Willd.) the plants which are more resistant to the herbicides, it is expedient to do the spraying two years in succession. When the weed encroachment is light, or when the choking up is by plants, which are very sensitive to 2.4D, for instance by Geranium pratense L., one spraying is enough; it can be repeated once every 3-4 years.

Dying out or inhibition of many varieties of grasses proceed as a result of utilization of herbicides 2.4D and 2M-4X; this favors a development of grain grasses and their increase in the content of the stand of grass. But the grains do not succeed to occupy all the places which were cleared by the perished grasses. That is why the spraying of the variegated stands of grass by solutions of 2.4D and 2M-4X is followed by a lowering in the yield during the year when herbicides are applied. This lowering will be the greater, the higher is the dose of herbicides, and the more varied is the grass; also the more there are of the plants which are especially sensitive to 2.4D and 2M-4X. During experiments by Dedinovskii experiment station of the Institute of Fodders (by T.V. Zosimovskaia) the yield of hay from the first mowing decreased by 25-38% after the spring spraying with 2.4D, and by using the herbicide on the aftergrowth the yield of the second mowing decreased by 10-26%. When spraying was done in spring, already in the

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second mowing one noted increase in yield through the expansion in the growth of the grains; thus, in all for two mowings with a spring spraying, the lowering in the yield of hay constituted 14-18%, and with the spraying of the aftergrowth - not more than 8-10% of the whole crop.

In the following years, in all the experiments the yield on plots treated by 2.4D was higher, than on the control, and the overall yield of hay for 2-3 years did not decrease, but even increased somewhat. Thus in one experiment, which was started in 1950, the yield for 4 years (1950-1953) on the control was 260 c of hay; with spraying during the root-leaf stage - 274 c; during the booting stage - 281 to 291 c, and during the aftergrowth - 256 c per 1 ha. Nonetheless, in many cases it is not expedient to allow even a temporary lowering of the yield in the meadows, because many kinds of grasses are relished by cattle, when they eat the hay. Thus, a continuous spraying should be applied in the first place in the stand of grass where predominate those plants which are not eaten by cattle, or in order to destroy poisonuous plants, if they are found in large numbers (where it is not expedient to use the selective spraying). A continuous spraying is especially advantageous on [Begin p.83] pastures, which are heavily choked up with poisonous plants, or with those which are not eaten by cattle.

Decrease in the yield of hay can be prevented during the year of spraying with herbicides by introducing fertilizers (mineral and organic). Experiments by Dedinovskii experiment station of the Institute of Fodders have confirmed the advantage of combined use of fertilizers and of herbicide sprayings. It was established, that when spraying is done in combination with an application of nitrogen fertilizers, the yield, in the year when herbicides are used, does not diminish; the effectiveness of fertilizers is not lowered, or is negligibly lowered, and sometimes is even increased, and

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the action of herbicides is heightened. On fertilized plots, after spraying with 2.4D occurs a fuller and faster destruction of various grasses. The diversity of grasses in such a case is lowered by 2-10%, compared to unfertilized plots, which were sprayed by 2.4D solution; besides this, the grain grasses became more numerous in the stand of grass.

In recent years application of nitrogen fertilizers is done in some raions, where there are large areas of bottom land meadows, particularly in Lukhovitskii raion, of Moscow oblast'. Many in the kolkhozes and sovkhozes became convinced of the high effectiveness and of an advantage in the use of fertilizers for supplemental feeding of the stand of grass in meadows.

On meadows with a high diversity of grass varieties and a small amount of legumes it is profitable to use nitrogen fertilizers together with a spraying with 2.4D. In such a case the fertilizers are applied early in the spring (often from an airplane), and the spraying is conducted later, when the warm weather becomes stabilized and the weeds are in a state of fast growth. With a combined utilization of nitrogen fertilizers and of 2.4D it is possible to obtain high yields of hay, which contains almost nothing but the valuable grain grasses.

On meadows which are heavily choked up by certain weeds, for instance Ranunculus repens L., the combined use of fertilizers and herbicides should be used two years in succession. Experiments, which were conducted in sovkhoz "Red poima" in Lukhovitskii raion, of Moscow oblast', and in the central part of the valley of the Oka river on half-bogs, which are overgrown by a stand of grass, made up of Ranunculus repens L. (T.V. Zosimovskaia, T. A. Rabotnov), have shown a possibility of creating here valuable stands of grass by using fertilizers and 2.4D even under conditions

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of stagnation of spring freshets. A three-year utilization of 2.4D destroyed almost entirely the Ranunculus repens L., and as a result of this a stand of grass has formed, which for the most part contained valuable grains (foxtail grass, canary grass, meadow grass - Poa trivialis L.); the yield on the third year, when 2.4D was used yearly, increased by 1.5 times; and , when in addition to this, NBK was applied (60 kg of the active substance per ha, per year) the yield increased almost two times (189%). Thus the half-bogs, which are overgrown by a stand of grass can be improved even without any additional sowing, but only by smothering the various grasses through spraying with a herbicide, and stimulating the growth of grains by an introduction of fertilizers, because in the valley soils there is always present a considerable amount of rudiments of valuable grains (seeds, rootstocks).

Consequently, until the meliorative works will be conducted, one can control the half-bogs, which are overgrown by various grasses, by introducing fertilizers and utilizing the herbicides.

Effectiveness of spraying with 2.4D, together with an application of phosphorus-potassium fertilizers, was studied on Dedinovskii experiment station of the Institute of Fodders. These fertilizers, under conditions of Dedinovskii station's bottom lands of Cma usually give a small effect, and only during the years of good growth of the legumes their effectiveness increases sharply. Experiments have established, that application of phosphorus-potassium fertilizers and use [Begin p.84] of 2.4D assist in an increase of legumes in the following years. It is better to introduce the fertilizers after, or immediately before treatment with the herbicide, otherwise the legumes can be harmed, as phosphorus and potassium stimulate their growth and development. 2.4D and PK can be utilized for improvement of various grasses of mountainous,

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and, to some extent, of lowland and of dry-gap meadows.

When treating the stands of grass by herbicides, and when a considerable part of the various grasses perishes, conditions are created which are favorable for an additional sowing of grasses, including the clovers. In an experiment, which was conducted in sovkhoz "Red poima", of the Lukhovitskii raion, Moscow oblast', in the central part of the bottom lands of the river Oka, on a meadow with a stand of grass of Ranunculus repens L., an additional sowing of Trifolium incarnatum L. was made in August, 1955 to the stand of grass, which was sprayed after it grew up after the first mowing; this sowing gave positive results. The next year the yield increased by 20% (+ 10 c per 1 ha). The content of grains grew from 25 to 64%, of legumes - from 0.1 to 10%, and the contents of various grasses decreased from 75 to 25%.

In order to raise the effectiveness of herbicides it is expedient to combine it with mechanical means of weed control, in particular, with cutting down the grass. This mowing down, especially if it is done in the period, when the reserve substances, which were stored in roots and rhizomes are exhausted, the plants are weakened and perish easier during the treatment by herbidides which follows. In the the experiments by D.I. Almazova (Dedinovskii experimental station of the Institute of Fodder) it was established, that Rumex confertus Willd., one of the most malicious weeds of the valley meadows, can be destroyed by means of a spring cutting down, followed by spraying with 2.4D of the grown sorrel and repeating this treatment two years in succession. In connection with this, it can be recommended to mow down the stands of grass which are highly choked up by Rumex confertus Willd. at the end of May or beginning of June, at the beginning of the booting stage, for silage or for green fodder, and after this to spray the stand of grass with 2.4D solution when sorrel has grown up. This method can be utilized for

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the control of many other weeds.

When the stand of grass contains large numbers of valuable grasses, which are sensitive to 2.4D and 2M-4X, it is expedient to use the selective spraying instead of the continuous. During a selective spraying the output of herbicide is reduced and a possibility to harm the leguminous and other valuable forage plants, which are senstive to 2.4D, is removed. But the selective spraying is hard to mechanize, and with the present equipment it demands a great expenditure of labor.

Use of Knapsack sprayers, because of an expenditure of much labor, can be recommendedqonly for small areas of especially valuable meadows. In order to conduct selective spraying, it is necessary to construct horse or motor sprayers with 2 or 3 hoses. Using these, it will be possible to conduct quickly and with small expenditure of labor a selective spraying of the stands of grass. Pack sprayers were constructed for mountainous regions (S. G. Miuge, S.D. Morozov).

Thus, methods of utilisation of herbicides on meadows and pastures can be different. It is more advantageous to use them jointly with other methods of utilization and improvement of meadows and pastures. This can guarantee a swift increase in the yielding capacity and an improvement of the quality of fodder.

* * *

Vast areas of fodder grounds, especially of pastures, are overgrown by thickets of half-grown trees and of brushwood. Elimination of these coppices and of the brushwood by mechanical means (by brushwood cutters, uprooters) costs very much and is done [Begin p.35] only on small areas. In several countries (especially in U.S.A.) 2.4D and 2.4.5T (2.4.5 trichlorphenoxyacetic acid), mainly esters and amino salts of these acids, are used for the

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elimination of trees and brushwood. As the experiments, which were conducted in U.S.A., have shown, treatment of pastures with 2.4D sharply increases their productivity. Thus, in one of the experiments the capacity of pastures rose 1.7 times, while at the same time a growth in livestock production per unit of the area increased by 78%. In our USSR the use of 2.4D for the elimination of trees and brushwood is conducted on the initiative of prof. N. P. Dekatov (TsNIILKh) [Central Scientific Research Institute of Forestry]. Research, which was done by N.P. Dekatov and his co-workers (M.G. Zeland, I.V. Shutov, and others), made it possible to recommend the use of sodium salt 2.4D for elimination of alder and of birch. Wide production tests of this method in many oblast' and republics have shown the high efficiency of sodium salt of 2.4D, used in a dose of 3-5 kg per 1 ha, when spraying was done from an airplane. Alders and birches usually dry up next year after treatment with 2.4D, whereupon no growth in the roots takes place. As a result of more light, as well as of decomposition of the forest flooring and of roots of dead trees, conditions favorable to the growth of grass are created. Forest grasses, which are of little value as forage, are replaced by meadow grasses, and their yield increases sharply. Especially productive stands of grasses are created after destruction of thickets of gray alders, which, being nitrogen gatherers, enrich the soil with nitrogen. At present, the problem of mechanization of the clearing of dead wood after treatments by 2.4D of forage lands, which were overgrown by brushwood and trees, is not yet solved. Yet, even without clearing of dead wood the productivity of pastures increases. No doubt the number of blood-sucking insects and of ticks decreases also under these circumstances. By using some of the simplest agrotechnical measures (burning of dead wood, introduction of phosphorus-

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potassium fertilizers, and additional sowing of seeds), it is possible to create highly productive pastures in place of thickets, covered by brushwood.

Aspen is immune to 2.4D, thus there is no sense in treating it with this herbicide. Use of chemical substances in order to eliminate willows is of great practical value, because they are very widespread on meadows, and especially in river valleys and lowlands. Willows are more resistant to 2.4D than gray alder and birch. Yet some of their kind can be eliminated with the use of sodium salt of 2.4D. A successful experiment in elemination of willows was done in the valley of the river Severnaia Dvina, in kolkhozes in the name of Malenkov and of Kaganovich, in Arkhangelskii oblast' (by L.A. Derbin). Observations in the valley of Oka river have shown that sodium salts 2.4D destroy the three-stamen willow (Salix triandra L.). Observations in Konstantinovskii raion, Moscow oblast' show that Russian willow (Salix rossica Nas.) is also sensitive to sodium salt of 2.4D. Many species of willows, which are immune to sodium salt of 2.4D can be destroyed by esters and amino salts of 2.4D and of 2.4.5T.

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A-705
(In part)
By: R. Adelman

Manchenkov, I.

O nakoplenii, prigotovlenii i primenenii navoza i drugikh organicheskikh udobrenii.

[Stock-piling, preparation and application of manure and other organic fertilizers]

In Kobrin, B., ed. O sistemo udobreniia rastenii v travopol'nykh sevooborotakh, p.42-60, Moskva, Moskovskii Rabochii, 1951. 57.09 K79

(In Russian)

A 705

p.55-56: AMOUNT OF MANURE

It has been established that, as the amount of manure is increased up to 40 and even 60 tons per ha, the yield of field crops increases accordingly. If, however, there is a shortage of manure, then, with a view to its more efficient utilisation, it should be recommended that its application to field crop rotations under grain crops and potatoes be carried out at a rate which does not exceed 15-20 tons per ha. It is better to reduce the amount of manure and to extend the area to which it is applied. This will result in considerably higher returns per ton of fertilizer in the form of increased yields and in considerable growth of the gross yield of agricultural production, shown in tables 8 and 9.

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Table 8.

Returns for manure through yield increases of winter rye in relation to amount of manure (As per data of the Moscow Regional Experimental Station)

Rate indicators	Podzolic soil. Amount of manure (in t/ha)		
	16	27	36
Increase in yield derived from total amount of manure (in c/ha)	5.6	6.4	8.6
Increase in yield per ton of manure applied (in kg/ha)	51.1	23.7	18.9

Table 9.

Returns for manure through yield increases of potatoes in relation to amount of manure (As per data of the Moscow Regional Experimental Station)

Rate indicators	Podzolic soil. Amount of manure (in t/ha)			
	16	36	54	72
Increase in yield derived from total amount of manure (in c/ha)	60	99	121	129
Increase in yield per ton of manure applies (in kg/ha)	333	275	224	179

With rare exceptions, it is better to fertilise two fields in crop rotations at the rate of 15-20 tons per ha of manure, than one field at the rate of 30-40 tons per ha.

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A-706
(In part)
By: V. Makarenko

Samoilov, I. I.

Sistema udobreniia v sevooborotakh nechernozemnoi zony.

[System of fertilization in crop rotations in non-chernozem zone]

Moscow, Ogiz-Sel'khozgiz, 1948.
127p.7, 57.7 Sa4S

(In Russian)

p.51: Table 25

Action and aftereffect of various doses of manure

Fertilizers in t/ha	Indicators of yields	1945, potatoes variety Kobler	1946, mangel-wursel, variety Ekkendorfskaia	1947, cabbage variety Slav
Control, without fertilizers	Yield in c/ha	160.0	170.8	257.2
	Increase in c/ha	-	-	-
	Increase in per cent	-	-	-
manure 20 t/ha	Yield in c/ha	201.4	202.2	276.6
	Increase in c/ha	41.4	31.4	19.4
	Increase in per cent	25.9	18.4	16.6
manure 40 t/ha	Yield in c/ha	212.4	242.7	290.1
	Increase in c/ha	52.4	71.9	52.9
	Increase in per cent	32.8	42.1	22.3
manure 60 t/ha	Yield in c/ha	220.8	268.5	294.6
	Increase in c/ha	60.8	97.7	37.4
	Increase in per cent	38.0	57.2	24.2

p.68-121: INSTANCES OF FORMATION OF FERTILIZATION SYSTEMS IN VARIOUS CROP ROTATIONS

As was cited earlier (p.10) the general and the most important feature for all crop rotations which are being introduced in different zones of USSR, including the non-chernozem zone, is its fodder-grass cultivation

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character. This was clearly expressed in the resolution of CNK (Council of Soviet Commissars) of USSR of June 21, 1946 "About measures on improvement of the task of introduction and utilization of crop rotations in kolkhozes"; "An indispensable condition for introduction of correct crop rotations must be an inclusion of fodder-grass cultivation, with a wide utilization of crops of grass mixtures of legumes and cereal perennial grasses, recommended by Academician Vil'iams, as also a raising on time and a good cultivation of afallows."

According to the above government resolution in Kolkhozes of non-chernozem zone the widest spreading should be given to grassland agriculture, to vegetable or vegetable - fodder-grass crop rotations, and to fodder crop rotations on the newly brought under cultivation marshy and swamped lands.

In the leading multi-field kolkhozes, as a rule, there is not one crop rotation but a coordinated system of crop rotations. Thus, for instance, kolkhoz "Pobeda", Dmitrovski raion, Moscow oblast' has simultaneously three grass crop rotations - field, fodder and vegetable; kolkhoz "Krasnoe Trosukhino", Kalininski oblast' has two grass crop rotations - field and fodder, and so on.

System of crop rotations in the cited and in other leading kolkhozes of the non-chernozem zone takes into account the natural conditions and c also the prospects of development of the many-sided economy.* [Begin p.89] In the greater part of kolkhozes and sovkhozes of non-chernozem zone, where crop rotations were introduced, there are combinations mostly of field and vegetable, or vegetable - fodder crop rotations.

* V. C. Dmitriev. Crop rotations and a system of agriculture. Gosplanizdat. Moscow, 1947.

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In connection with this, when studying instances of formation of systems of fertilization in various crop rotations our main attention will be directed also to field, vegetable, and vegetable-fodder crop rotations. However, taking into consideration an important significance and good prospects for a wide spreading into the agricultural production of fodder crop rotations as one of the component parts of grassland agriculture, we shall touch briefly on basic considerations of forming systems of fertilization for such crop rotations also.

It is self-evident, that when solving problems of systems of fertilization, which are applicable to one or another crop rotation, we should always keep in mind that a system of fertilization is linked to other elements in grassland agriculture (system of rotations, system of cultivation and system of caring for crops), and base the methods of fertilizations in accordance with these elements.

Variants for systems of fertilization for field-grass crop rotations

We meet a great variety of field crop rotations in different oblast' and raions of the non-chernozem zone in connection with the direction of tillage, which is determined by the main crop of the rotation, as well as with the heterogeneity of natural and economic conditions.

Yet it is possible to isolate individual types of crop rotations among these varieties of crop rotations, as those which reflect the main direction of tillage in non-chernozem zone. These will include crop rotations where main crops will be flax, grains and potatoes. All these crop rotations include plantings of perennial legumes and cereal grasses - clover and timothy; besides this, in all these crop rotations, independent

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of the main crop, a considerable part of the area is given to grain crops. In connection with the above said, our consideration of problems of formation of systems of fertilization we shall conduct on instances of typical [Begin p.90] crop rotations for leading crops, mentioned above. But before starting these considerations, let us pause briefly on the results of experiments of many years, which were conducted by scientific institutions on studying the effectiveness of various systems of fertilization in field crop rotations.

An extensive work of studying the effectiveness of applied systems of fertilization in field crop rotations, with flax as the leading crop, was conducted in prewar years under the direction (sentence continued on p.91, after table 33).

Table 33.

System of fertilization in kolkhozes "Krasnyi l'novod" and "imeni Lenina".

Rotation of crops	Fertilizers used				
	manure t/ha	Ammonium nitrate c/ha	Superphosphate c/ha	40% Potassium salt c/ha	Phosphorite meal c/ha
	Kolkhoz "Krasnyi l'novod"				
1. Fallow, clean	20-25	-	1.5	-	4.0
2. Winter	-	1.0	-	1.00	-
3. Clover-first year	-	-	2.5	1.12	-
4. Clover - second year	-	-	-	-	-
5. Flax	-	0.9	4.2	2.00	-
6. Potatoes 34%	15-16	0.9	2.5	1.12	-
Spring wheat 33%	15	1.2	2.5	0.75	-
Barley 33%	15	0.9	2.5	0.75	-
7. Oats	-	0.6	-	-	-
Average amount of fertilizer per 1 ha of plowed land	6-6	0.5	1.6	0.7	0.6
	Kolkhoz "imeni Lenina"				
1. Fallow, clean	20-25	-	1.6	-	4.0
2. Winter	-	0.9	-	0.6	-
3. Clover 1st year	-	-	-	-	-
4. Clover 2nd year	-	-	-	-	-
5. Flax	-	0.9	4.2	2.0	-
6. Potatoes 34%	12-15	-	2.6	1.12	-
Spring wheat 33%	12-15	0.6	2.5	-	-
Barley 33%	12-15	0.6	2.5	-	-
7. Oats	-	-	-	-	-
Average amount of fertilizer per 1 ha of plowed land	5.6	0.4	1.2	0.5	0.6

[Begin p.91]

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of VIUAA in two kolkhozes of Nekouzskogo raion, Iaroslavskoi oblasti - "Krasnyi l'novod" and "imeni Lenina". Up to 1933, these kolkhozes did not differ from others in the raion in their yields, their level of agrotechnics nor in the use of fertilizers, but they adopted and practiced before 1941 the following systems of fertilization in crop rotations (see table 33). At the same time both kolkhozes improved their agrotechnics year after year.

Technique of fertilizer utilization in the cited system comprised the following. Manure and phosphorite meal in the fallow was introduced under the first spring plowing, superphosphate under the pre-sowing plowing or cultivation. Top dressing of winter crops and of clover with mineral fertilizers was conducted on early spring dates. Under flax 2/3 of phosphoro-potassium fertilizers were introduced in the fall, under autumn plowing, the rest - in spring before cultivating the plowland; nitrogen fertilizers were used as top dressing in the phase of "herring-bone design" ("elochka"). Under potatoes and spring grains all the fertilizers were introduced in spring, plowed under.

Systematic use of fertilizers and an improved agrotechnics have brought the cited kolkhozes to the front, among many leading farms of the raion, in the yielding capacity of crops (data of yields according to years and crops, in comparison with initial data of yields are given in table 34).

T a b l e 34.

Yield (in c/ha) in kolkhozes "Krasnyi l'novod" and "imeni Lenina"

Name of crops	Kolkhoz "Krasnyi l'novod"				Kolkhoz "imeni Lenina"			
	1932 initial year	1933-1936	1937-1939	1940-	1932 initial year	1933-1936	1937-1939	1940
Flax for fibre	2.52	5.6	4.4	4.9	2.28	3.43	3.71	4.16
Grain	9.7	13.2	16.2	18.2	8.6	9.4	14.6	18.4
Potatoes *	53	109	103	157	51	89	98	143
Clover of the 1st year	35	61	46	-	29	43	42	-
Clover of the 2nd year	19	34	33	-	20	33	33.5	-

* Low yield of potatoes is explained, apparently, by small doses of manure and of mineral (especially nitrogen) fertilizers.

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[Begin p. 92]

Thus, on the kolkhozes under consideration, to the end of the first crop rotation the yielding capacity increased: in flax up to 4.2-4.9 c/ha, that is two times; in grain crops up to 18.2-18.4 c/ha, that is also two times and in potatoes up to 143-157 c/ha, or almost three times compared to the initial yield.

Mineral fertilizers played an immense role in the increase of yields of agricultural crops in both kolkhozes. Results of calculations of action of these fertilizers during the period 1936-1940 are given in table 35.

T a b l e 35.

Additional yields (in c/ha) from mineral fertilizers in kolkhozes "Krasnyi l'novod" and "imeni Lenina"

Name of crops	Kolkhoz "Krasnyi l'novod"			Kolkhoz "imeni Lenina"		
	1933-1936	1937-1939	1940	1933-1936	1937-1939	1940
Flax for fibre	1.1	1.5	1.6	1.0	1.3	1.5
Grain	3.9	4.1	6.1	2.9	4.2	4.8
Potatoes	24.6	29.8	56.8	19.3	19.5	30.0
Clover - 1st year	17.1	15.0	-	11.0	7.4	-
Clover - 2nd year	8.9	7.6	-	5.3	6.3	-

The noted increase of yields by years finds an explanation in the addition of direct action of fertilizers, introduced in the given year, to the residual action, or the aftereffect of fertilizers, which were introduced in preceding years.

Data of VIUAA show, that correctly used mineral fertilizers give a great economical effect. Thus, for instance, in 1940, kolkhoz "Krasnyi l'novod" received from mineral fertilizers additional production for 41629 rubles, and kolkhoz "imeni Lenina" - for 62726 rubles. Thus, the use of mineral fertilizers helped to increase the pay of a work-day in kolkhoz "imeni Lenina" by 80 copecs and in kolkhoz "Krasnyi l'novod" by 1 ruble.

Let us also pause on the experiment of many years, conducted by the

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of Leningrad oblast', on medium-podzolic light clayey soil in [Begin p.93] a rotation of crops as follows: 1) potatoes, 2) barley with additional sowings of clover and timothy, 3) clover with timothy of 1st year, 4) clover with timothy and 2nd year, 5) winter rye, 6) grain legumes, and 7) oats.

The following variants of fertilizer utilization in a crop rotation were tried:

I - without fertilizers;

II - manure in the amount of 20 t/ha under potatoes and 20 t/ha under winter rye;

III - full mineral fertilizer (ammonium sulfate 2.25 c/ha, superphosphate 5.5 c/ha and potassium salt 1.5 c/ha) under potatoes and winter rye; superphosphate (2.5 c/ha) for grasses in the 1st year; superphosphate and potassium salts (1.5 c/ha) for grasses in the 2nd year.

IV - manure and mineral fertilizers in amounts, shown in variants II and III;

V - manure and mineral fertilizers with a dose increased from variant IV; dose of manure (up to 30 t/ha) under potatoes;

VI - manure, mineral fertilizers and liming; in this variant manure and mineral fertilizers were taken in similar amounts as in variant V, but lime was added in an amount of 6 t/ha under barley with an additional sowing of perennial grasses.

Table 86.

Yielding capacity of crops (in c/ha) *

No. of fields in crop rotation	Crops	Variants of systems of fertilization					
		I	II	III	IV	V	VI
1	Potatoes, year of 1934	134.4	187.8	157.2	219.4	219.4	219.4
2	Barley " " 1936	12.3	15.7	15.6	20.1	19.0	19.0
3	Grasses of the 1st year (hay), 1936	17.7	33.4	22.4	29.4	38.3	40.1
4	Grasses of 2nd year (hay), 1937	18.1	30.6	19.2	27.4	36.8	46.5
5	Winter rye, 1938	9.8	21.2	21.0	24.2	24.6	25.5
6	Oats, 1939	6.2	6.4	9.0	10.9	11.7	12.7

* For details on above see: N.A. Sapozhnikov, V. V. Krotov, and others. Experiment in studies of agrotechnical bases of system of fertilization. Trudy Len. otd. VIUAA, no. 58, 1938. [Begin p.94]

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It is necessary to note, that in variants III and IV ammonium nitrate was used as top dressing for barley.

Results for the first 6 years are given in table 36.

Data of table 36 establish the evident advantage of manure-mineral system, especially with the use of liming compared to one-sided mineral or manure system of fertilization. This advantage becomes still more convincing, if one compares the indicators of agrochemical qualities of the soil after 5 years on the control, and on basic avariants of fertilization systems (table 37).

T a b l e 37.

Changes of agrochemical qualities of soil under the influence of various systems of fertilization

Agrochemical indicators	Variants of fertilization systems				
	I	II	III	IV	VI
Active acidity (pH)	5:17	5:50	4:86	5:45	6:76
Hydrolytic acidity (in m/eqv.)	4:15	3:39	5:85	3:93	1:80
Sum total of absorbed bases (in m/eqv.)	5:66	5:78	5:58	4:70	7:34
Free aluminum (in mg)	5.24	2.17	7.19	4.15	0

As seen from table 37, only the one-sided mineral system of fertilization does not improve the soil properties in proportion to acidity, and does not decrease, but even increases (on acid soil) the contents of free aluminum, which can, as stated previously, produce a negative influence on the development and growth of plants.

Whereas manure, manure-mineral and, especially, manure-mineral with the use of liming, systems decrease or fully eliminate the acidity of the soil and the content of aluminum, as well as improves the physical properties of the soil, owing to the increase in its saturation by calcium (lime).

Besides this, under the influence of simultaneous use of lime, organic and mineral fertilizers, the content of nutrients, accessible to plants, increases considerably.

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The stated results of many years of production experiments testify about great possibilities of obtaining high yields of all agricultural [Begin p.95] crops with an improvement in soil fertility with the aid of an efficient fertilizing system together with high agrotechnics. Taking into consideration these results, and also all the above cited materials below we give concrete instances of formation of fertilization systems for the following 4 yfield crop rotations.

First crop rotation - seven fold, having flax as the leading crop and a rotation of crops: 1) clean fallow, 2) winter (rye and wheat) with additional sowing of grasses (clover and timothy), 3) grasses - 1st year, 4) grasses ofthe 2nd year, 5)flax, 6) potatoes and grain legumes, and 7) oats.

This crop rotation reflects well the agrotechnical correct rotation of crops.

Let us conditionally assume, that the soils of the kolkhoz area, where the crop rotation is situated are podzolic clayey, medium cultivated, with high acidity.

Second crop rotation - eightfold - grains as the main crop. In this crop rotation the alternation is: 1)clean fallow, 2) winter grains, 3) spring grains, with additional sowing of grasses (clover and timothy), 4) grasses - 1st year, 5) grasses - 2nd year, 6) winter and spring grains, 7) potatoes, and 8) spring grains (oats).

Soils same as in the above case. An essential disadvantage of this crop roation is the sowing of a part of winter grains on the layer of perennial grasses.

Third crop rotation - also eightfold with the following rotations: 1) clean fallow, 2) winter grains with additional sowing of perennial grasses (clover and timothy); 3) grasses - 1st year, 4)grasses - 2 nd year,

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5) spring wheat, barley; 6) early potatoes and grain legumes; 7) winter rye (after early potatoes) and potatoes (after legumes), and 8) spring grains.

A positive property of this crop rotation is its agrotechnical consistency with an increased percentage of winter grains and preservation of a whole field (in a sum total) under potatoes.

Soils are medium-podzolic, light and medium-clayey, lightly cultivated.

Fourth crop rotation - ninefold with a high percentage of potatoes, which is of great importance for suburban regions with the following crop rotations: 1) clean fallow, 2) winter grains, 3) potatoes and legumes, 4) barley and winter rye with additional sowing of grasses (clover and timothy) (Sentence continued on page 98, after table 38)

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Table 38. Trans. A-706

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Scheme of allocation of fertilizers in a field, sevenfold crop rotation on medium cultivated podzolic clayey soil

No. of the field	Rotation of crops	Basic fertilization			Top dressing		
		Types of fertilizer	Doses in c/ha	Time of introduction and method of plowing under	Types of fertilizer	Doses in c/ha	Time of introduction and method of plowing in under
1	Clean fallow	Lime [illegible] Manure Superphosphate	30-40 200-300 200-500 2-3	Under autumn plowing or spring cultivation of fallow Under first plowing Under first or the presowing plowing	-	-	-
2	Winter grain with additional sowing of grass (clover and timothy)	-	-	-	Liquid manure poultry droppings, or ammonium nitrate	100-120 4-6 0.5-0.75	Before harrowing in spring
3	Grasses - 1st year	-	-	-	Ashes or superphosphate and potassium chloride	8-10 2-3 1.0-1.5	Early in spring or after first mowing with subsequent harrowing
4	Grasses - 2nd year	-	-	-			
5	Flax	Superphosphate	3-4	Under fall plowing or during early spring frosts with a preplanting plowing under	Ammonium nitrate Potassium chloride	0.8 0.6	During mass appearance of sprouts During the "herringbone" phase
6	Potatoes	Peat - manure mixture or peat compost Ammonium nitrate Superphosphate Potassium chloride Ashes	300-400 1.5 2.5 1.0 6-8	During fall plowing, part (1/3-1/2) nitrogen phosphorous fertilizers into the hills at planting time During plowing	-	-	-
7	Grain legumes - Spring grains (oats, barley)	-	-	-	-		-

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5) grasses of the 1st year, 6) grasses of the 2nd year, 7) spring wheat, 8) potatoes and 9) oats.

Soils medium-podzolic, lightly clayey or sandy loam, highly cultivated.

Let us examine, on the example of the first crop rotation, the basic problems of formation of a system of fertilization, given in table 38.

The high acidity of the soil calls for a necessity of liming, which, as it was already pointed out, it is most expedient to concentrate on the fallow field. Depending on local conditions, liming should be done either in full doses or in reduced doses of lime (2-3 times during the rotation of crops). The first case is taken in the table, and the dose, calculated on the bases of acidity and of the mechanical composition of soil, comprises about 5-6 t/ha. But taking into consideration the response of flax to liming the dose of lime must be decreased to 3-4 t/ha. Technique of lime's introduction is shown in the table.

Organic fertilization is concentrated on two fields of the field crop rotation, each of which must receive, if possible, not less than 20-30 t/ha of these fertilizers.

When choosing various kinds and forms of fertilizers, the manure, as a more slowly and longer acting fertilizer (compared to composts), is the first to be utilized on the fallow of the crop rotation, and, especially, for winter wheat; under winter rye it is quite possible to effectively utilize peat-manure mixtures.

As was proved previously, organic fertilizers must be supplemented by phosphorus (or phosphoro-potassium) mineral fertilizers, in this case- superphosphate. If the fallow was not limed, it would be better to use instead of superphosphate the difficultly dissolving phosphates - phosphorite meal or bone meal in a one and one half dose.

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On furrow plowed field of the crop rotation, which is occupied by potatoes and the grain legumes, potatoes get as a basic fertilizer the peat-manure mixture, or peat-manure or other composts with an addition of nitrogen-phosphorus-potassium mineral fertilizers; stove ashes can be used instead of potassium, and of a part of phosphorus fertilizers. It is quite expedient in this field to use 2/3 of organic fertilizers during fall plowing, and 1/3 - as a compost into the hills [Begin p.99] at planting of potatoes (together with nitrogen-phosphorus mineral fertilizers). Fertilization of grain legumes in the same field can be limited to using Nitragin (simultaneously with seeds at sowing) and stove ashes (6-8 c/ha).

It is desirable to use a top dressing on perennial grasses of the 1st or 2nd year, using phosphorus-potassium (or only phosphorus) mineral fertilizers or, in their absence, stove ashes. Dose of superphosphate must be about 2-3 c/ha, dose of potassium chloride 1-1.5 c/ha; dose of stove ashes, more or less equivalent in contents of nutrients to the above mineral fertilizers consists of 8-10 c/ha.

The problem about which of the two grass fields should be fertilized, when there is enough fertilizer for just one field, is solved depending on the condition of grasses and on the fertilization of fallow. When the condition of grasses is more or less similar, but not quite satisfactory on both fields and when the fallow was not fertilized sufficiently, the preference is given to grasses of the 1st year, as, according to the experience of kolkhozes this will bring higher increases in yields from the use of fertilizers. When grasses on the field of 2nd year of use are very sparse, the fertilizers are introduced into that field, and not to the grasses of the 1st year.

In both cases the above cited fertilizers are applied on the surface

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of grasses in the early spring, when clover starts to grow.

A special attention must be given to fertilize the seed sections of clover.

Flax, which is placed in the fifth field of the crop rotation must be furnished with soluble mineral fertilizers - superphosphate in a dose 3-4 c/ha and potassium chloride in a dose 1-1.5 c/ha.

All mineral fertilizers, with the exception of nitrogen, are introduced under fall plowing, or (including nitrogen) during early spring frosts, with a subsequent preplanting plowing under.

Spring grains (oats, and barley in part) in the last field of the crop rotation utilize the aftereffect of fertilizers, which were introduced under the foregoing crops.

For an increase in yields of crops in the rotation, the use of local and mineral fertilizers for top dressing is of great importance. For winter crops it is necessary to provide a nitrogen top dressing in the early spring (on frozen soil). At this time the activity [Begin p.100] of the useful microbes of the soil, on account of low temperature, is weakened, and the winter grains need an additional nitrogen feeding. For this type of top dressing, before harrowing the winter crops, it is necessary to apply liquid manure, diluted 2-3 times by water in an amount of 10-12 t/ha, or dry, ground poultry droppings - in 4 to 5 c/ha, or ammonium nitrate 0.6 to 0.75 c/ha.

Top dressing must be also provided for the fifth field of the crop rotation - for flax. Ammonium nitrate is the most valuable mineral fertilizer, and it must be utilized precisely in this field in the amount of 0.6-0.8 c/ha. Top dressing must be applied before the onset of the "herring-bone design" phase ("elochka") in flax. In order to prevent lodging of flax and to im-

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prove the quality of the fibres it is good to apply a second top dressing with potassium chloride or potassium salts at the advent of the "herring-bone design" phase. ("elochka").

The approximate calculation, which were done by us for the provision with nutrients of all crops of the studied sevenfold crop rotation using norms of fertilizers cited in the table, show that the given system of fertilization allows to expect the following yields: of grains of 20-25 c/ha, of grasses of 35-40 c/ha, hay and potatoes not less than 250 c/ha. It is necessary, though, to stress, that, when forming a system of fertilization, it is necessary to aim at a higher enrichment of the soil by phosphorus, taking into consideration that plants can utilize it only lightly from introduced fertilizers. A certain lack of nitrogen can be compensated at the expense of the activity of useful microorganisms (with good agrotechnics) and of the root remnants of grasses. A shortage in potassium in the introduced potassium fertilizers can also be partly replenished at the expense of mobilizing potassium from the reserves of the soil, when it is cultivated correctly.

A scheme for allocation of fertilizers in the first of the eightfold crop rotation, with an additional sowing of grasses under spring grains and utilizing the grass sod for winter and spring grains is given in table 39.

First distinction of the system of fertilization for this crop rotation consists in the following: order to bring liming nearer to perennial grasses, it is conducted here in the 3rd field, which is occupied by barley, with an additional sowing of grass. Taking into consideration the high sensitivity of barley to the acidity of soil, one can expect a considerable increase from lime, which was applied already in the first year, in barley with a growing effect on the following crops. [Begin p.101]

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The second peculiarity of the system of fertilization in this crop rotation consists in the necessity of introducing fertilizers (stove ashes or phosphoro-potassium) under grasses of the 1st year, because barley as the cover crop here, does not get separately any basic fertilizer, but utilizes the aftereffect of fertilizers.

Finally, the third peculiarity, which is tied to the presence of the second winter field (or part of the field) consists in the expediency of using organic fertilizers in three fields of the crop rotation, that is additionally to the fallow and to the furrow-plowed field under the second winter crop in the form of even a small dose of compost, together with phosphoric-potassium fertilizers or stove ash. However, when the growth of perennial grasses is good it is possible to get by without the introduction of organic fertilizers under the second winter crop; yet, introduction of phosphorus-potassium fertilizers in this case is still more necessary.

For the second eightfold crop rotation, which is more successful, from the point of view of agrotechnical consistency for requirements of grass crop rotations, the scheme of allocation of fertilizers is given in table 40.

Into this scheme are introduced several significant changes, compared to the foregoing one. First of all, as the soil was only slightly cultivated, it was expedient here to enrich with fertilizers, the crop rotation more full; in particular, to utilize organic fertilizers in increased doses.

Secondly, organic fertilizers under potatoes in this crop rotation are divided between the sixth and the seventh fields, whereupon the early potatoes receive a well decomposed manure, but the medium and the late varieties of potatoes get the peat-manure mixture with an addition of stove

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ashes and of a top dressing.

Thirdly - both the winter crops receive a top dressing.

As the soil is poor in nutritive substances, doses of mineral fertilizers here are given higher, in particular for grasses and grain legumes. In this crop rotation on lighter soils great importance is given to top dressings, which are conducted in four fields.

For a ninefold crop rotation we shall limit ourselves with the following remarks according to the system of fertilization, offered in table 41.

A well cultivated soil, on which this crop rotation is situated, allows to decrease the doses of of organic fertilizers in the fallow and the furrow-plowed fields, and to increase doses of mineral, especially potassium, fertilizers. [Begin p.102]

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Scheme of allocation of fertilizers in the field, eightfold crop rotation on medium cultivated podzolic clayey soils.

No. of the field	Rotation of crops	Basic fertilization			Top dressing		
		Types of fertilizer	Doses in c/ha	Time of introduction and method of plowing under	Types of fertilizer	Doses in c/ha	Time of introduction and method of plowing under
1	Clean fallow	Manure	200-300	Under the first plowing	-	-	-
		Superphosphate	2-3				
		Phosphorite meal or Bone meal	3.0-4.5	Same or under the preplanting plowing			
2	Winter grains	-	-	-	Liquid manure or poultry droppings	100-120 4-5	Before harrowing in spring
					Ammonium nitrate	0.5-0.75	
3	Spring grains (barley) with additional sowing of clover and timothy	Lime	50-60	Under fall plowing or spring plowing over, or cultivation of plowland	Ammonium nitrate (on seed plots)	0.8	During mass appearance of sprouts
4	Grasses - 1st year	-	-	-	Ashes or superphosphate	8-10 2.5-3	Early in spring or after first mowing with subsequent harrowing
					Potassium chloride	1.0	
5	Grasses - 2nd year	-	-	-	-	-	-
6	Winter Spring grains Spring wheat	Compost	150-200	Under the plow, when plowing the clover field	-	-	-
		Superphosphate	3				
		Potassium chloride or Stove ashes	1.0-1.5 10-12				
		Superphosphate	2-3	Same	Ammonium nitrate	0.8	During mass appearance of sprouts
		Potassium chloride	0.75-1.0				
7	Potatoes	Peat manure	300 100				
		Ammonium nitrate	1.5	1/2 under plow and 1/2 into the hills at planting time			
		Superphosphate	2-3				
		Potassium chloride	0.75-1.0				
8	Spring grains (oats)	-	-	-	-	-	-

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Table 40.

Scheme of allocation of fertilizers in the field, eightfold crop rotation on slightly cultivated podzolic, light and medium clayey soils

No. of the field	Rotatation of crops	Basic fertilization			Top dressing		
		Types of fertilizer	Doses in c/ha	Time of introduction and method of plowing under	Types of fertilizers	Doses in c/ha	Time of introduction and method of plowing under
1	Clean fallow	Lime	40-50	During spring cultivation after plowing	-	-	-
		Peat	200	After first spring plowing			
		manure	200				
		superphosphate	3.5				
		Potassium chloride	1.0				
2	Winter grains with addition sowing of grasses (clover and timothy)	-	-	-	Ammonium nitrate	0.5-0.75	Before harrowing in spring
3	Grass - 1st year	-	-	-	Ashes	3-4	-
4	Grass - 2nd year	Ammonium nitrate	1.0-1.5	-	Superphosphate	3.5-4	Early in spring on the surface
					Potassium chloride	1.5	
5	Spring wheat barley	Superphosphate	3.0	Under plow, when clover field is plowed ammonium nitrate with spring cultivation	-	-	-
		Potassium chloride	1.0				
6	Early potatoes and grain legumes (peas, vetch)	Well decomposed manure	200	Under fall plowing			
		Ammonium nitrate	1.0	"			
		superphosphate	2.0	"			
		Potassium chloride	0.75				
		Superphosphate	2.3				
		Potassium chloride	0.75-1.0				
7	Winter rye, after potatoes	-	-	-	Liquid manure	100-120	Before harrowing in spring
					superphosphate or poultry droppings	1.5-2	
	Potatoes (after grain legumes)	Peat	300	Under first spring plowing		4-5	
		manure	100		Ammonium nitrate	0.8-1	At harrowing the sprouts or with first hilling
		ashes	8-10		Potassium chloride	0.5-0.75	At second hilling
8	Spring grains (oats,	-	-	-	"	-	-

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Table 41.

Scheme of allocation of fertilizers in a rising, mineral crop rotation on cultivated slightly-podzolic light clay and sandy loam soils.

No of the field	Rotation of crops	Basic fertilization			Top dressing		
		Types of fertilizers	Doses in c/ha	Time of introduction and method of plowing under	Types of fertilizers	Doses in c/ha	Time of introduction and method of plowing under
1	Clean fallow	Manure	200	Under first spring plowing			
		Phosphorite or bone meal	3-4				
		Potassium chloride	1.0	Same or under pre-planting plowing	-	-	-
2	Winter grains	Under-sowings	-	-	Liquid manure or poultry droppings	100-120 4-5	Before harrowing in spring
3	Potatoes	Peat manure	200 100	Under fall plowing; mineral fertilizers partially into the furrow at planting			
	Grain legumes	Ammonium nitrate superphosphate Potassium chloride	1-5 3.0 1.5		-	-	-
		Potassium chloride	1.0-1.5				
4	Barley with additional sowing of grasses and winter grains with addit. sowing of grasses	-	-	-	Ammonium nitrate	0.75	At the mass appearance of sprouts
5.	Grasses - 1st year	-	-	-	Superphosphate Potassium chloride	2.5-3 1.5	Early in spring
6.	Grasses - 2nd year	-	-	-	-	-	-
7	Spring wheat	Ammonium nitrate Superphosphate Potassium chloride	1.0 3.0 1.0	Early in spring on frozen ground with following cultivation; superphosphate and potassium salt are better to apply under fall plowing	-	-	-
8.	Potatoes	Manure or Compost	200 200	At planting of potatoes into the hills	Ammonium nitrate Potassium chloride	0.8-1 0.5-0.75	When harrowing the shoots At second hilling
9.	Spring grains (oats, barley)	-	-	-	-	-	-

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There is no need for liming here for the same reason. Difficultly soluble phosphoric fertilizers are introduced on the fallow, as an addition to manure, with an expectation that microbiological activity will increase with good cultivation of the fallow, and will create favorable conditions for the conversion of phosphoric acid, in the cited fertilizers, into a form which is readily assimilated by plants.

Potatoes, in the eighth field of the crop rotation, which are planted on the plowed stubble, get a smaller dose of the more thoroughly decomposed organic fertilizer, which is introduced locally; its effectiveness must be very high, because of the favorable soil and agrotechnical conditions.

When using, in practice, all the above cited instances of systems of fertilization, it is necessary to seriously consider specific local conditions, according to which one whould introduce suitable corrections to the cited schemes.

Variants for systems of fertilization for vegetable and vegetable-fodder-grass crop rotations

In recent years vegetable and vegetable-fodder-grass crop rotations received a wide spreading in different regions of the non-chernozem zone in connection with the creation of powerful vegetable-potatoes and milk-livestock raising bases around industrial centers and large cities.

In contrast to previously existing 8-4 field vegetable crop rotations without grasses in kolkhozes and sovkhozes, which occupied small personal plots, in many kolkhozes, the newly introduced, and those which already existed vegetable and vegetable-fodder-grass crop rotations bear, almost exclusively a grassland agriculture character; they occupy extensive land areas. Vegetable crop rotations without grasses, at present time, are rare

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occurrences; one can find them mostly in suburban kolkhozes and sovkhozes, and they are usually situated on well cultivated pre-farm areas.

As the introduced vegetable and vegetable-fodder-grass crop rotations occupy, in most cases, slightly and medium cultivated podzolic soils, planning of an efficient system of fertilization for these crop rotations is of great interest. According to government assignments, the yield of vegetables on [Being p.109] fertilized areas must be, on the average not less than 240-260 c/ha, and, thus, methods of how to apply fertilizers to vegetable crops become still more important.

It is necessary to emphasize, that the formation of systems of fertilization for vegetable and for vegetable-fodder-grass crop rotations is a quite new problem, which has no foundation in appropriate experiments by scientific institutions.

That is why, when sloving the practical problem of a system of fertilization for such crop rotations, special attention should be given to the local, specific conditions (of a kolkhoz, or a sovkhoz) one should utilize as fully as possible the practical experience of leaders in the use of fertilizers for vegetable crops, as well as consider the above mentioned directions on fundamental conditions for formation of a system of fertilization in crop rotations.

Below are given instances of utilization of fertilizers in vegetable and vegetable-fodder-grass crop rotations, which can be of production value in various oblast' of non-chernozem zone.

First one - a sixfold vegetable-fodder-grass crop rotation, which we shall (conditionally) place on a slightly cultivated, medium-podzolic clayey soil; it has the following rotation of crops: 1) barley, with an additional sowing of grasses (clover and timothy, 2) grasses - 1st year,

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3) grasses - 2nd year, 4) cabbage, 5) roots for fodder, plants for silage and early potatoes, 6) table roots (beets, carrots, and others).

Second - sixfold vegetable crop rotation, is situated on better cultivated, light clayey soils and has the following crop-rotation: 1) barley and oats, with additional sowing of grasses (clover and timothy), 2) grasses of the 1st year, 3) grasses of the 2nd year, 4) cabbage and turnips, 5) cucumbers, tomatoes, early potatoes, and legumes, 6) table roots (beets and carrots).

Third - sevenfold, vegetable-fodder-grass crop rotation, with an emphasis on early potatoes, is situated on medium cultivated, light and medium clayey podzolic soils, with the following rotation of crops: 1) barley and oats, with additional sowing of grasses (clover and timothy), 2) grasses of the 1st year, 3) grasses of the 2nd year, 4) cabbage, cucumbers, tomatoes, 5) fodder roots and plants for silage, 6) early potatoes, 7) table roots, onions for bulbing.

Fourth - fourfold vegetable crop rotation without grasses, adapted to well cultivated slightly podzolic clayey soils; [Begin p.110] has such a rotation of crops: 1) cabbage, 2) cucumbers and tomatoes, 3) table roots - beets, carrots and other vegetables, 4) early potatoes.

Proceeding to the examination of samples of formation of systems of fertilization for the cited crop rotations, it is necessary to note, that considerable amounts of mineral fertilizers, which were released, since 1946, for the food crops (including vegetables), allow to introduce many changes in the previously recommended schemes of allocation of fertilizers in crop rotations by utilizing industrial, ineral fertilizers on a wider scale.

Scheme of allocations of fertilizers in the first of the cited crop rotations is given in table 42. One of the most important measures for this crop rotation, which is on soils of high acidity, is liming of the soil.

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Liming is applied to the first field, which is occupied by barley, with an additional sowing of perennial grasses. It can be conducted either with the full dose of lime, in this given case about 6 t/ha, or with a decreased dose of lime, 2-3 t/ha, but done 2-3 times in the course of the full rotation of crops.

For barley, lime is applied during the preplanting cultivation of the soil. A second time, during crop rotation in the same field, lime can be introduced under cabbage. An additional top dressing, done locally in hills for cabbage, and in furrows for beets in small doses (8-10 c/ha) is quite an effective and a desirable method, especially at the beginning of the crop rotation.

Fertilization of perennial grasses, in the crop rotation under consideration, is very important because the slightly cultivated podzolic soils, as a rule, are poor in nutritive substances, especially phosphorus. Application of phosphorus-potassium fertilizers is done to grasses of the 1st year, because the cover crop does not get any fertilizers. Dose of mineral fertilizers, in accordance with the cited properties of the soil, is given slightly stepped up compared to average norms (table 27).

All the basic vegetable and fodder crops of the crop rotation receive fertilizers, and, first of all, local organic fertilizers. For cabbage, which is planted in the fourth field on the turned sod of perennial grasses, are offered different variants of organic fertilizers: peat-fecal compost, mixture of peat with manure, or the city garbage. In order to utilize, for a longer time, the favorable qualities of the sod of perennial grasses in the crop rotation, the above mentioned organic (sentence continued on page 112, after table 42). [Begin p.111]

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Table 42.

Scheme of allocation of fertilizers in the vegetable-fodder sixfold crop rotation on slightly cultivated medium podzolic clayey soils.

No. of the fields	Rotation of crops	Basic fertilization; forms and doses of fertilizers in c/ha	Top dressings; forms and doses of fertilizers in c/ha	
			First	Second
1 1.	Barley with additional sowing of grasses (clover and timothy)	Lime 20-30	-	-
2.	Grasses - 1st year		Superphosphate 3-3.5 Potassium chloride 2.0	
3.	Grasses - 2nd year	-	-	-
4.	Cabbage	Peat-fecal compost 250-300 or peat-manure mixture 400-500 or house garbage 600-800 Superphosphate 3.0-4.0 Potassium chloride 1.5	Liquid manure, diluted - 200 and superphosphate 1.0	Nitre 0.9 Superphosphate 1.0 Potassium chloride 0.6
5.	Fodder roots (mangel wurzel, turnips)	Manure 200 Ammonium nitrate 1.6 Superphosphate 3.5 Potassium chloride 1.5	-	-
	Silage (sunflower, fodder cabbage)	Likewise	-	-
	Early potatoes	Ammonium nitrate 1.5 Superphosphate 3.0 Potassium chloride 1.5	-	-
	[Begin p.112]			
6.	Table roots (beets, turnips	Peat compost 300-400	Nitre 0.4	Nitre 0.4
		Superphosphate 2.5 Potassium chloride 2.0	Superphosphate 1.0 Potassium chloride 0.5	Superphosphate 1.0 Potassium chloride 0.6
	Carrots	Humus 200 Superphosphate 3.0 Potassium chloride	Nitre 0.2 Superphosphate 0.5 Potassium chloride 0.15	Nitre 0.4 Superphosphate 0.6 Potassium chloride 0.3

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fertilizers are applied during the spring cultivation of the plowland, which was plowed in the fall by a plow with a colter, or into the furrows during ridge plowing. In order to obtain better effectiveness and economise on the peat fecal compost, it is recommended to apply it locally - into the hills, when planting cabbage seedlings. Organic fertilizers are supplemented by mineral.

On the fifth field of crop rotation, the fodder roots and silage crops receive manure and full mineral fertilizer. Dose of manure is decreased because of its joint use with mineral fertilizers, and also because these crops are utilizing the aftereffects of organic fertilizers which were applied to cabbage.

Early potatoes, which can properly utilize the after effects, get only mineral fertilizers. From among table roots, beets and turnips in the sixth field, which are planted after the fairly well fertilized fodder roots and the silage crops, and carrots, which follow them, receive the more thoroughly decomposed forms of organic fertilizers together with mineral. It would be quite expedient to apply part of these fertilizers locally.

Top dressing of vegetable crops in vegetable-fodder-grass crop rotations along with the basic fertilization is a sure method of a correct system of plant feeding. [Begin p.115]

Cabbage, late and medium, receives top dressing 2 or 3 times, depending on the state of the crop, and the early one - 1 or 2 times. All three nutritive substances, that is nitrogen, phosphorus and potassium, are needed for top dressing.

The first top dressing for cabbage is done after seedlings take root (about 10-12 days after they have been planted into the soil) and applied into the hills or furrows on both sides of the plants to the depth of 6-8 cm, the holes being 10-12 cm away from the plants. The second top dressing is

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is done at the beginning of the head formation in cabbages, that is 20-25 days after the first top dressing to the depth of 10-12 cm. The third top dressing is done 15-20 days after the second and to the same depth.

All the previously cited forms of local fertilizers are suitable for cabbage. When liquid manure, which does not contain phosphorus is used as top dressing, it is necessary to add to it superphosphate (in an amount of 1 c/ha) for each feeding.

According to the character of utilization of nutritive substances, the liquid manure is applied during the first top dressing in a dose of 5 t/ha of undiluted manure, which in a quadruple dilution with water gives 20 t/ha, or from 0.5 L (for early cabbage) up to 1 L (for late cabbage) of solution for each plant. In our instance mineral fertilizers are given as the second top dressing, but one can utilize local fertilizers in such a case too.

Supplemental feeding of beets and carrots is conducted once or twice. First top dressing is given after the first thinning of plants, the second - after the second thinning. Fertilized watering is introduced into the furrows between plant rows: during the first feeding to the depth of 4-6 cm, during the second, to the depth of 10-12 cm.

In our instance mineral fertilizers are utilized as top dressing. In case of using local fertilizers, it is necessary to prepare weaker solutions for carrots, especially of such fertilizers, as poultry droppings (dilute dry poultry droppings 15-20 times) and cow dung (dilute 10 times). One liter of solution of local or mineral fertilizers is spent for beets on 1-1.5 m, and for carrots on 1.5-2 m of the row.

The second sixfold vegetable crop rotation according to the system of fertilization must differ from the foregoing in several peculiarities, because it is placed on more highly cultivated (sentence continued on page 115, after table 45) [Begin p.114]

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Table. 43

Scheme of allocation of fertilizers in a vegetable sixfold crop rotation on cultivated, slightly podsolic, light clayey soil.

No. of the field	Rotation of crops	Basic fertilization; forms and doses of fertilizers in c/ha	Top dressings; forms and doses of fertilizers in c/ha	
			1st.	2nd.
1.	Barley, oats with additional sowing of grasses clover and timothy)	-	-	-
2.	Grasses - 1st year	-	Superphosphate 3.0	
3.	Grasses - 2nd year	-	Potassium chloride 1.5	-
4.	Cabbage and turnips	Well decomposed manure - 200 during cultivation of plowland and 100 into hills at planting	-	Liquid manure, diluted 200 Superphosphate 1.0
5.	Cucumbers	Peat-manure mixture 400, under plow	Nitre 0.4 Superphosphate 1.5 Potassium chloride 0.5	Nitre 0.3 Potassium chloride 0.6
	Tomatoes	Compost - 200 under plow and 100 into the hills at planting	-	Nitre 0.6 Superphosphate 1.5 Potassium chloride 0.6
	Early potatoes	Compost 200 Ammonium nitrate 1.5 Superphosphate 2.5 Potassium chloride 1.0 into the furrow at planting	- -	-
	Legumes [Begin p.115]	Superphosphate 4.0 Potassium chloride 1.6	-	-
6.	Table roots: beets	Ammonium nitrate 2.5 Superphosphate 3.0 Potassium chloride 1.6	-	Nitre 0.9 Superphosphate 1.0 Potassium chloride 0.6
	Carrots	Ammoninum nitrate 1.5 Superphosphate 2.5 Potassium chloride 1.5		Nitre 0.6 Superphosphate 0.5 Potassium chloride 0.8

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slightly podzolic soils and includes in its composition fruit - vegetables (table 43).

1. Liming of the soil is not needed; although a local application, under beets and mangel wurzel, of small doses of lime, mixed with mineral fertilizers, in the sixth field will bring an increase of the effectiveness of fertilizers.

2. Use of a combined method of manure application under cabbage and turnips in the fourth field, which will allow to conduct only the second supplemental feeding (the first supplemental feeding being substituted by a local application of manure into the hills). The same refers also to tomatoes in the fifth field.

3. The preceding enrichment of soil by organic substances from root remnants of grasses and a high state of cultivation of the soil make it possible to somewhat decrease doses of organic fertilizers under cabbage, turnips and cucumbers, and use only mineral fertilizers (without organic) under the table roots.

4. Introduction into the crop rotation of fruit-vegetable crops (cucumbers and tomatoes) calls for a need in supplemental feeding for these crops. [Begin p.116]

Top dressing for cucumbers is usually done twice: first - at the appearance of the third true leaf, second -at the beginning of fruit bearing, 20-25 days after the first top dressing.

Mineral fertilizers (as in our instance), or all of the other cited local fertilizers, with the exception of feces, can be used for top dressing. The concentration of the solution must be decreased about 2 times, as it is done for carrots, compared to the concentration which is used for cabbage.

The supplemental feeding is applied to the furrows on two sides of

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the plant row; the first feeding at a distance of 6-8 cm from the row and to a depth of 4-6 cm; the second - in between the rows to a depth of 10-12 cm. One liter of the fertilizer solution is used for 1 m of the furrow during the first feeding. For the second top dressing, in conformity with the peculiarities of cucumber feeding, superphosphate is excluded or its dose is decreased, but the doses of ammonium nitrate and of potassium salt are increased. 1.5 L of solution is used for 1 m of the furrow.

Tomatoes, like the late and medium cabbage, are fed supplementally 2 or 3 times. Local fertilizers are introduced in approximately the same quantities as for cabbage, with one difference, that the amount of superphosphate, which is added to liquid manure, is increased here up to 1.5 c/ha. First feeding (10-15 days after planting the seedlings) is applied into the hills to the depth of 4-6 cm and at a distance of 6-8 cm from the plants.

In our instance, according to the above cited reason, the first supplemental feeding is not done.

The second top dressing (at the beginning of fruitbearing - about 20-25 days after the first), and, in case of necessity, the third (15-20 days afte the second) is done to the depth of 10-12 cm. Nitrogen and, especially, potassium feeding of plants is increased for the second and third top dressing. For the first feeding a pail of solution is spent for 20 plants, for the subsequent ones - for 10 plants.

It is necessary to stress, that the most important condition for a high effect of the top dressing (as well as of the basic fertilization), on the yielding capacity of vegetable crops is the adherence to methods of correct agrotechnics for each crop.

The last of fodder-grass crop rotations, which was taken by us for observation, is the sevenfold vegetable-fodder-grass crop rotation; it differs

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from the two first crop rotations only (sentence is continued on page 118)after table 44) [Begin p.117]

Table 44.

Scheme for allocation of fertilizers in the vegetable-fodder-grass sevenfold crop rotation on medium cultivated, light and medium clayey podzolic soils.

No. of the field	Rotation of crops	Basic fertilization forms and doses of fertilizers in c/ha	Top dressings; forms and doses of fertilizers in c/ha	
			1st	2nd
1.	Barley, with additional sowing of grasses (clover and timothy)	Lime 20	-	-
2.	Grasses of the 1st year	-	Superphosphate 3.0 Potassium chloride 1.6	-
3.	Grasses of the 2nd year	-	-	-
4 Ca	Cabbage, Cucumbers	Manure 300-400 or peat-manure mixture 400-500 Ammonium nitrate 2.0 Superphosphate 3.0 Potassium chloride 1.6	-	Nitre 0.9 Superphosphate 1.0 Potassium chloride 0.5
	Tomatoes	Peat compost 200 Superphosphate 3.0-4.0 Potassium chloride 1.0	Liquid manure 200 Superphosphate 1.5	Nitre 0.6 Superphosphate 1.5 Potassium chloride 0.6
5.	Fodder roots and plants for silage	Peat-fecal compost 200-300 Superphosphate 3.5 Potassium chloride 1.5	-	-
	Early potatoes	Ammonium nitrate 1.5 Superphosphate 2.5 Potassium chloride 1.0	-	-
6.	Table roots: beets	Peat compost 300 Superphosphate 3.0 Potassium chloride 1.5	Nitre 0.4 Superphosphate 1.0 Potassium chloride 0.3	Nitre 0.8 Superphosphate 1.0 Potassium chloride 0.6
	carrots and onions (for bulbing)	Humus 200 Superphosphate 2.5 Potassium chloride 1.0	Nitre 0.2 Superphosphate 0.5 Potassium chloride 0.15	Nitre 0.4 Superphosphate 0.5 Potassium chloride 0.3

[Begin p.118]

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by the presence of a whole field under early potatoes and a combination in one field of cabbage and of fruit-vegetable crops. In connection with this, the scheme shown in table 44, (sentence is continued on page 119, after table 46).

Table 45.

Scheme of allocation of fertilizers in a vegetable crop rotation on well cultivated slightly podzolic clayey soils.

No of the field	Rotation of crops	Basic fertilization forms and doses of fertilizers in c/ha	Top dressings; forms and doses of fertilizers in c/ha	
			1st	2nd
1	Cabbage	Manure 300	Nitre 0.6 Superphosphate 1.0 Potassium chloride 0.3	Nitre 0.9 Superphosphate 1.0 Potassium chloride 0.6
2.	Cucumbers	Manure 400	Nitre 0.4 Superphosphate 1.5 Potassium chloride 0.3	-
	Tomatoes	Compost 200-300	Liquid manure 200 Superphosphate 1.5	Nitre 0.6 Superphosphate 1.5 Potassium chloride 0.6
	[Begin p.119]			
3.	Table roots: beets	Nitre 2.0 Superphosphate 2.5 Potassiumchlorides 1.5	-	Nitre 0.8 Superphosphate 1.0 Potassium chloride 0.6
	carrots	Nitre 1.6 Superphosphate 2.0 Potassium chloride 1.0		Nitre 0.4 Superphosphate 0.5 Potassium chloride 0.3
4.	Early potatoes	Peat compost or humus 200 Nitre 1.5 Superphosphate 2.5 Potassium chloride 1.0	-	-

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of allocation of fertilizers in this crop rotation does not require any additional explanations.

Also no elucidations are required on the scheme of allocation of fertilizers in the vegetable crop rotation without grasses on well cultivated, slightly podzolic, clayey soils (table 45).

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About the formation of systems of fertilization in fodder crop rotations

In connection with enormous development of livestock raising, which was projected in the Five-Year Plan, a proper organization of fodder bases in kolkhozes and sovkhozes is the most important problem.

Depending on the form and size of livestock raising procedure the requirements in fodder in amount and composition, are quite different, and, consequently, methods of their provision are also unequal. Without stopping, in detail, on this problem, because it does not enter our problem, we shall only remark, that for a series of oblast' and regions of non-chernozem zone, the problem about satisfying the needs of livestock raising in pasture fodders is very great. [Begin p.120].

Owing to lack of or to small productivity of natural fodder lands, for many kolkhozes and sovkhozes the time now is already ripe for the need of introduction of special fodder crop rotations in order to provide their livestock with cultivated pastures, as well as (in addition to the field crop rotations) with hay, and succulent, green fodders.

Two types of fodder crop rotations are in existence: a fodder crop rotation in field lands and a fodder crop rotation on low-productive natural pasture lands; this last one bears the name of meadow-pasture land crop rotation.

These crop rotations differ from one another as in the number of fields and composition of crops, so also in conditions of reinstating the fertility of the soil. In connection with this, the character of the system of fertilization must differ very much; it must be worked out for each crop rotation at the time of its introduction into a kolkhoz of sovkhoz.

A system of fertilization for fodder crop rotations on field lands will have much in common in its formation with a system of fertilization for ve-

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getable-fodder crop rotations (which are placed on lands adjacent to farmsteads). A basic difference in these systems is, that in the fodder crop rotation the main attention must be directed to the increase of yields of fodder roots, of plants for silage and of perennial grasses by means of greatest utilization of local forms of fertilizers, particularly of liquid manure, feces and peat-fecal combinations, and on acid soils also to liming.

In kolkhozes and sovkhozes of the non-chernozem zone from among the fodder crop rotations the meadow-pasture land crop rotations have the greatest value, aespecially in the presence of vegetable-fodder crop rotations. The following two eightfold crop rotations can serve as examples of such crop rotations:

I. 1) vetch, together with oats for green fodder, 2) silage plants and roots, 3) spring grains with additional sowings of grasses, 4 and 5) grasses for hay, 6,7 and 8) grasses for grazing.

II. 1) oats, 2) vetch with oats, 3) oats with additional sowings of grass, 4 and 5) grasses for hay, 6,7 and 8) grasses for grazing.

Crop rotations, like the second one of the above cited, are usually placed on lands which are further away from the farmstead, where cultivation of such hard-to-transport crops as fodder roots and plants for silage is unsuitable.

One of basic conditions for a proper system of fertilization for meadow-pasture land crop rotations is liming, if these crop rotations are placed on turf-podzolic [Begin p.121] and swampy lands with a heightened acidity. On slightly acid soils liming can be successfully substituted by the use of phosphorite meal in increased doses (1.5-2 t/ha). Thus, together with the elimination of acidity, the soil is also enriched by wphosphoric acid, which will produce a protracted positive action on the yields of crops in the crop rotation.

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Liming or enriching the soil with phosphorite is best done in the third field of both crop rotations, which are occupied by spring grains with an additional sowing of grasses.

It is very important, at least during the initial period (and on poor soils, systematically), to introduce, in the above mentioned crop rotations, manure and other organic fertilizers, timing it to the second clover crop of both crop rotations, and thus drawing them nearer to the perennial grasses. From among other local fertilizers liquid manure and stove ashes must also be widely used; the first principally for silage plants and roots, the second also for grasses.

One of the promising methods in the system of fertilization of meadow-pasture land crop rotations is the use of mineral, and first of all, of phosphorus-potassium fertilizers, which must assist in the increase of the general productiveness of crop rotations and in the improvement of the quality of production, in particular of the quality of hay and of pasture fodder.

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By: R. Adelman

Maidin, P.

O sisteme udobreniia rastenii v travopol'nykh sevooborotakh moskovskoi oblasti.

[System of plant fertilization in grass-field crop rotations in the Moscow Region]

In Kobrin, B. ed. O sisteme udobreniia rastenii v travopol'nykh sevooborotakh, p.3-41. Moskva, Moskovskii Rabochii, 1951. 57.09 K79

(In Russian)

pp:33-41: TABLE

Table 7.

Fertilization system of a ten-field and eleven-field field-crop rotation on flax growing kolkhozes. In ten-field crop rotations

Rotation system	System of Fertilization							
	At slight saturation with fertilizers				At increased saturation with fertilizers			
	Manure (in c/t/ha)	Ammonium nitrate	Superphosphate (Phosmeal)	Potassium chloride	Manure (in c/t/ha)	Ammonium nitrate	Superphosphate (Phosmeal	Potassium chloride
		(in c/ha)				(in c/ha)		
1. Grasses	-	-	-	-	-	-	1.5	0.5
2. Grasses	-	-	-	-	-	-	-	-
3. Flax	-	0.8	2.5	0.5	-	1.0	3.0	0.75
4. Root and leaf crops	9	0.8	1.5	0.5	15	1.0	2.0	0.75
5. Spring grain crops	-	-	0.6	-	-	0.8	0.5	-
6. Cropped fallow [par zaniatyi]	-	0.8	0.5	-	10	0.8	1.0	-
7. Winter crops	20	0.8	2.0	0.5	20	0.8	2.0	0.5
8. Spring grain crops	-	-	-	-	-	0.8	1.5	0.5
9. Clean fallow	20	-	1.5	1.0	25	-	2.0	1.0
10. Winter crops + grasses	-	0.8	0.5	-	-	0.8	0.5	-
Total for crop rotation	49	4.0	9.0	2.5	70	6.0	14.0	4.0
per hectare of plowland	4.9	0.4	0.9	0.25	7.0	0.6	1.4	0.4

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Table 7. (Continued).

In an eleven-field crop rotation: Crop rotation with supplementary seeding of grasses under spring grain crops

Rotation system	System of fertilization: At slight saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride	At increased saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride
1. Grasses	-	-	-	-	-	-	1.5	0.5
2. Grasses	-	-	-	-	-	-	-	-
3. Flax	-	0.8	2.5	0.5	-	1.0	3.0	0.75
4. Root and Leaf crops	10	0.8	1.5	0.5	20	1.0	2.0	0.75
5. Spring grain crops	-	-	0.5	-	-	0.8	0.5	-
6. Cropped fallow	-	0.8	0.5	-	10	0.8	1.0	-
7. Winter grain crop	20	0.8	0.5	-	20	0.8	2.0	-
8. Spring grain crops	-	-	-	-	-	0.8	1.5	0.5
9. Clean and cropped fallow	30	-	1.5	0.5	30	-	2.0	0.75
10. Winter crops	-	0.8	0.5	-	-	0.8	0.5	-
11. Spring grains + grasses	-	0.8	2.5	1.0	-	0.8	2.5	1.0
Total for crop rotation	60	4.8	10.0	2.5	80	6.6	16.5	4.25
Per ha of plowland	6.6	0.44	0.9	0.25	7.3	0.6	1.5	0.4

Table 8.

Fertilization system of a nine-field field-crop rotation with two fields of potatoes and no clean fallow: Crop rotation with supplementary seeding of grasses under winter crops

Rotation system	System of fertilization: At slight saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride	At increased saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride
1. Grasses	-	-	-	-	-	-	1.5	0.5
2. Grasses	-	-	-	-	-	-	-	-
3. Winter + spring crops	-	0.8	2.5	0.5	20/2	0.8	2.5	0.5
4. Potatoes	9	1.0	1.5	0.5	15	1.0	1.5	0.5
5. Cropped fallow	10	-	1.5	0.5	10	0.8	1.5	0.5
6. Winter crops	-	0.8	0.5	-	-	0.8	0.5	-
7. Spring grain	-	-	-	-	-	0.8	0.5	-
8. Early potatoes	30	1.0	1.5	0.5	30	1.5	2.0	0.75
9. Winter grain grasses	-	0.8	2.5	1.0	15	0.8	2.5	0.75
Total for crop rotation	49	4.4	10.0	3.0	85	6.5	12.5	3.5
Per ha of plowland	6.1	0.6	1.1	0.38	10.6	0.8	1.4	0.6

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Table 8. (Continued)

Crop rotation with supplementary seeding of grasses under spring grain crops

Rotation system	System of fertilization: At slight saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate (in c/ha)	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride (in c/ha)	At increased saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate (in c/ha)	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride (in c/ha)
1. Grasses	-	-	-	-	-	-	1.6	0.6
2. Grasses	-	-	-	-	-	-	-	-
3. Winter / spring crops	-	0.8	2.6	0.6	20/2	0.8	2.6	0.6
4. Potatoes, early	9	0.8	1.6	0.6	15	1.6	1.6	0.6
5. Winter crops	10	0.8	1.6	0.6	10	0.8	1.6	0.6
6. Cropped fallow	-	-	1.6	-	-	0.8	0.6	-
7. Winter crops	15	0.8	0.6	-	20	0.8	2.0	0.6
8. Potatoes	20	1.0	1.6	0.6	30	1.6	2.0	0.75
9. Spring grain / grasses	-	0.8	2.6	0.75	-	0.8	2.6	0.75
Total for crop rotation	54	6.0	11.6	2.75	85	7.0	14.0	4.0
Per ha of plowland	6.0	0.66	1.8	0.3	9.4	0.8	1.6	0.4

Table 9.

Fertilization system of eleven-field field-crop rotation on kolkhozes of the grain districts in the Moscow Region: Crop rotation with supplementary seeding of grasses under winter crops

Rotations system	System of fertilization: At slight saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate (in c/ha)	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride (in c/ha)	At increased saturation with fertilizers — Manure (in t/ha)	Ammonium nitrate (in c/ha)	Superphosphate (Phosmeal) (in c/ha)	Potassium chloride (in c/ha)
1. Grasses	-	-	-	-	-	-	1.6	0.6
2. Grasses	-	-	-	-	-	-	-	-
3. Winter / spring crops	-	0.8	2.6	0.6	20/2	0.8	2.6	0.6
4. Root and leaf crops	9	0.8	1.6	0.6	15	1.6	1.6	0.75
5. Cropped fallow	-	-	-	-	-	0.8	0.6	-
6. Winter crops	10	0.8	0.6	-	15	0.8	2.0	0.6
7. Cropped fallow	-	-	-	-	-	0.8	0.6	-
8. Winter crops	15	0.8	0.6	-	15	0.8	2.0	0.6
9. Spring grain	-	-	-	-	-	0.8	0.6	-
10. Clean fallow	15	-	1.6	0.6	25	-	2.6	0.75
11. Winter grain / grasses	-	0.8	0.6	-	-	0.8	0.6	-
Total for crop rotation	49	4.0	7.0	1.8	80	7.1	14.0	3.6
Per ha of plowland	4.5	0.36	0.64	0.14	7.3	0.65	1.3	0.32

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Table 9. (Continued).

Crop rotation with supplementary seeding of grasses under spring crops

Rotation system	System of fertilization							
	At slight saturation with fertilizers				At increased saturation with fertilizers			
	Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal)	Potassium chloride	Manure (in t/ha)	Ammonium nitrate	Superphosphate (Phosmeal)	Potassium chloride
		in c/ha				in c/ha		
1. Grasses	-	-	-	-	-	-	1.5	0.5
2. Grasses	-	-	-	-	-	-	-	-
3. Winter / spring crops	-	0.8	2.5	0.5	20/2	0.8	2.5	0.5
4. Spring grain crops	9	0.8	1.5	0.5	15	1.5	1.5	0.75
5. Cropped fallow	-	-	-	-	-	0.8	0.5	-
6. Winter crops	10	0.8	0.5	-	15	0.8	2.0	0.5
7. Spring grain crops	-	-	-	-	-	0.8	0.5	-
8. Clean fallow	15	0.8	0.5	-	15	0.8	2.0	0.5
9. Winter crops	-	-	-	-	-	0.8	0.5	-
10. Root and leaf crops	15	-	1.5	0.5	25	-	2.5	0.75
11. Spring grain / grasses	-	0.8	0.5	-	-	0.8	0.5	-
Total for crop rotation	49	4.0	7.0	1.5	80	7.1	14.0	3.5
Per ha of plowland	4.5	0.36	0.64	0.14	7.3	0.65	1.3	0.32

[Begin p.39] Winter wheat is manured at a rate of not less than 18 tons per ha combined with 3-4 centners of phosphorite meal. Sandy and sandy-loam soils, as well as peat soils, should be fertilized also with potassium fertilizers at the rate of 0.6-0.75 centners per hectare of potassium chloride. In addition, 0.6 centners of granular superphosphate should be applied to rows at the time of seeding, and in the early spring - 0.6-1.0 centners of ammonium nitrate and 0.5 centners of granular superphosphate per hectare in the form of supplementary feeding.

Winter rye is fertilized in the same order as winter wheat over the whole cropping area of regional seed farms, specialized farms, and on seed plots on kolkhozes, and also wherever perennial grasses are seeded in addition to winter rye.

To the rest of the winter rye cropping area should be applied no less

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than 15 tons per ha of manure, and 0.6 c/ha of granular superphosphate in rows and, in addition, rye nutrition should be supplemented in the spring with nitrogen and local fertilizers.

Spring wheat is fertilized with complete mineral fertilizer at the rate of: 1.25 centners of ammonium nitrate, 2 centners of superphosphate and 0.75 centners of potassium chloride per hectare. On lighter soils it is desirable to increase the amount of nitrogen. When spring wheat is seeded on a good freshly plowed layer after perennial grasses, then the amount of nitrogen can be decreased to 0.8 c/ha.

Spring grain crops under which are seeded supplementary perennial grasses are to get phosphorus and potassium fertilizers (2-3 c/ha of superphosphate and 0.75-1 c/ha of potassium chloride). Manure should be applied under the crop preceeding in crop rotation - potatoes or sprouts of winter crops [ozim'] - in increased amounts (not less than 20-30 tons per ha).

Potatoes over the whole cropped area should be given 20-30 tons per hectare of manure in combination with complete mineral fertilizer at the rate of at least 0.8 centners of ammonium nitrate, 1.5 centners of superphosphate and 0.5 of potassium chloride. If fertilizer reserves are limited, application they should be applied locally when potatoes are planted (in the furrows or in hills). In such a case manure is applied at the rate of 9-10 tons per ha together with superphosphate and nitrogen fertilizers (also in small amounts).

Forage root crops and silage crops are to get manure on the entire cropped area and, besides, on 50% of the area, mineral fertilizers at the rate of 1.5 centners of ammonium nitrate, 2 centners of superphosphate and 1 centnersof potassium chloride per hectare.

Vegetable crops on the entire cropped area must be given mineral fertilizers at the following rate in addition to manure.

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Table 10.

	Ammonium nitrate	Superphosphate	Potassium chloride
Cabbage	2.5-3	3-3.5	1.5
Garden beets	2	3	1
Carrots	1.5	2-2.5	0.75
Onions	1.0	2.5	0.75-1
Cucumbers	2	3	0.75-1
Tomatoes	2	4	0.75-1

Flax is fertilized with complete mineral fertilizer on the whole area (0.8-1 centner of ammonium nitrate, 2.5-3 cnetners of superphosphate and 0.5-0.75 centner of potassium chloride per hectare).

All other technical crops (kok-saghyz, sugar beet), and also maize must be provided with fertilizers in full measure.

Grasses of previous years on approximately 1/3 of their cropping area are given supplementary nutrition consisting of potassium phosphate fertilizers (1.5 c/ha of superphosphate and 0.5 c/ha of potassium chloride) in the early spring, or after the harvest of cover crops. At first, supplementary nutrition is provided for grasses on specialized farms and on seed plots on kolkhozes. Supplementary feeding of grasses emerged from under insufficiently fertilized cover crops is practiced everywhere. To supplementary food of grasses, particularly those grown for seed, are added also magnesium boride [bormagniebye] fertilizers at the rate of 0.5-0.75 c/ha.

In making use of tables 7, 8 and 9 one must keep in mind the following:

1. Peat and composts, in appropriately adjusted amounts, should be

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applied to crop rotation fields subject to manuring, if manure is unavailable.

2. Lime is applied to the field of a grass cover-crop in time to be plowed under, or under presseeding tillage at the rate of 1 to 2 tons per ha on sandy loam soils, and from 2 to 3 tons per ha on clayey soils.

3. From the total amount of phosphorus fertilizers demonstrated in the scheme under any crop in a rotation of crops, a part (at the approximate rate of 0.6 c/ha) is to be applied to rows or the furrow in the form of factory made granular superphosphate, or organo-mineral granules containing superphosphate.

4. Phosphorite meal is to be applied instead of superphosphate, first of all, to fallow fields, as a rule, in the same amount as superphosphate, and, preferably in compost with manure. In addition, phosphorite meal, instead of superphosphate, should be applied to crop rotation in turning over the soil layer.

5. Potassium chloride can be replaced by a 40-percent potassium salt if the amount is adequately increased by approximately 50%.

* * *

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(Abstract and tables)
By: R. Adelman

Dobrotvorskaia, M. M.

Ispol'zovanie navoza v travopol'nykh sevooborotakh.

[Utilization of manure in grass-field crop rotations]

Nauchnaia Konferentsiia po Probleme Ispol'zovaniia Mestnykh Istochnikov Udobrenii Ukrainskoi SSR. Trudy. 1951:31-41. 57.09 N22

(In Russian)

The February, 1947 Plenum provided, among other things, for the use of organic and mineral fertilizers. In accordance with the plan for the adaptation of grass-field crop rotations, the system of Dokuchaev, Kostychev and Vil'iams is being stressed. Experiments conducted by the All-Union Scientific-Research Institute of Sugar Beets [Vsesoiuznyi Nauchno-Issledovatel'skii Institut Sakharnoi Svekly] and by many of its stations show that excellent results are achieved by applying combinations of manure and mineral fertilizers. Organic fertilizers improve air humidity, physico-chemical properties and microbiological activity in the soil, and they reduce harmful concentrations of salts.

The Verkhniach, Ivanov, L'gov and Ramonsk experimental stations have conducted a study of the following systems:

a) in using the organo-mineral system, called the fundamental one, manure is applied to fallow under winter crops at the rate of 25 tons per ha, and under sugar beets it is applied under the plow in turning over fresh grassland at the rate of 20 tons per ha, which amounts to 25-30% of the total amount of nutritive elements contained in organic fertilizers for crop rotation. In this system mineral fertilizers are applied to the leading crops

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used in crop rotation - winter and spring wheats, sugar beet, to transplantation of [garden] beets, and under grasses;

b) in the mineral system of fertilizers, the amount of nutritive elements is equivalent to their content in the organo-mineral system;

c) in the organo-mineral system of fertilizers, manure contains 50% of the total amount of nutritive substances used in crop rotation;

d) in the organo-mineral system, all manure (45 tons per ha) is applied to fallow under winter crops;

e) the organo-mineral system in which manure is applied under beet crops;

f) the organo-mineral system applying manure to fallow under winter crops and under grasses;

g) the organo-mineral system in which manure is applied to fallow under winter crops and to transplantation of beets.

In these variations in the fertilization system the amount of nutritive substances introduced in a crop rotation remains the same.

Grass-field crop rotations in which fertilizer systems are studied are as follows: 1) fallow, 2) winter wheat, 3) transplantation of beets, 4) spring grains with a supplementary sowing of grass mixture, 5) grass mixtures, 6) grass mixtures, 7) spring wheat, 8) sugar beets.

A t the Verkhniach Station the amount (in kg/ha) of nutritive substances and manure in the basic organo-mineral fertilizer system is:

Crop	N	P_2O_5	K_2O	Manure, t/ha
Winter crop sprouts	30	70	60	25
Transplantation	50	70	70	--
Grass mixture	22	45	45	--
Spring wheat	30	70	60	--
Beets	100	120	100	20

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The amounts, however, vary. On the whole, organo-mineral combinations produce better results than mineral fertilizers alone. On soils rich in organic substances derived from grasses, manure is less effective. On soils in which motility of organic substances is poor, manure exerts a positive influence.

Attention must be directed also to the quality of manure. Some experiments have demonstrated that aerobic manure, regardless of considerable losses of organic substances and nitrogen, improves in quality as a result of a less difficult hydrolysis of compounds with a nitrogen and carbon content. Results obtained in experiments conducted in 1948 at the Belotserkov and Pervomaisk Stations confirmed the hypothesis that the influence exerted by aerobic and anaerobic manure upong the yield of winter and spring wheat, perennial grasses and sugar beets is practically the same.

The results of investigations conducted by the All-Union Scientific-Research Institute of Sugar Beets and by its stations have demonstrated that grass-field crop rotations are a fundamental and decisive factor in rendering the action of organic and mineral fertilizers more effective, in creating more favorable environmental conditions for plant growth and nutrition, and in obtaining high and stable yields of all crops used in a crop rotation

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Table 1.

Effectiveness of fertilizers in crop rotations in experiments of the Verkhniach Experimental Selection Station in 1947 (Yield and increase in c/ha)

Fertilizer system	Grassfield	Crop rotation	Grassfield	Crop rotation
	Winter wheat		Spring wheat	Winter wheat
No fertilizer	24.6	23.5	16.0	16.2
Organo-mineral	4.3	2.4	3.7	1.9
Mineral	4.8	1.6	3.2	2.9
Fertilizer system	**Crop rotation**	**Grassfield**	**Crop rotation**	
	Beets	**Beets transplantation**		
No fertilizer	404.2	19.8	21.3	
Organo-mineral	53.8	1.6	1.1	
Mineral	6.4	2.8	3.7	

Table 2.

Effectiveness of fertilizers in crop rotations in experiments of the Ramonsk Station in 1947 (Yield and increase in c/ha)

Fertilizer system	Crop rotation	Grassfield	Crop rotation		
	Winter wheat	Spring wheat	Winter rye	Beets	Beet transplantation
No fertilizer	29.1	29.1	28.2	524.5	23.8
Organo-mineral	2.4	1.5	4.5	69.5	6.0
Mineral	1.4	—	2.7	61.4	2.5

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Table 3.

Effectiveness of fertilizers in crop rotation in experiments conducted at the Verkhniach Station in 1948 (yield and increase in c/ha)

System of fertilization	Grass-field					Control crop rotation				
	Winter wheat	Beet seed	Barley	Spring wheat	Sugar beet	Winter wheat	Beet seed	Barley	Winter wheat	Sugar beet
No fertilizer	38.4	25.4	12.9	10.7	244	36.2	29.4	11.5	34.1	225
Organo mineral	+0.6	5.6	1.6	-0.6	64	1.1	4.8	3.4	3.6	48
Mineral	+0.8	8.1	2.1	-0.2	73	+1.3	7.5	4.0	1.6	109

Table 4.

Effectiveness of fertilizers in rotation of grass-field crops in experiments of Ramonsk Station (1st allotment [Klin]) (Yield of crops in c/ha)

System of Fertilization	Years					
	1937		1938	1939		1940
	Winter wheat		Beets	Oats + grass		Grasses 1 yr.
	Grain	Straw	Roots	Grain	Straw	Hay
Organo-mineral	29.8	47.9	189	19.8	25.1	51.9
Mineral	30.0	49.0	173.4	18.4	28.1	49.7

System of fertilization	Years					
	1941	1945	1946	1947	Total for rotation	
	Grasses 2nd yr.	Transplant.	Oats	Fallow		
	Hay	Seed	Grain	--	Grain	Straw + hay
Organo-mineral	56.0	28.1	4.7	--	77.4	177.9
Mineral	55.2	22.6	3.7	--	75.8	182.0

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Table 5.

Influence of fertilizers upon the structural composition of soil in experiments of the Ramonsk Station

System of fertilization	Horizons cm	June 3, 1946 - fallow		May 14, 1947 - Winter wheat		May 16, 1947 transplanting
		Total positive structural elements	Total water resistant aggregates	Total positive structural elements	Total water resistant aggregates	Total water resistant aggregates
Organo-mineral	0-10	66.8	30.2	71.7	43.5	44.0
"	10-25	64.6	41.6	66.2	40.6	60.0
"	25-40	69.6	22.6	72.8	65.6	68.0
Mineral	0-10	65.6	28.8	71.6	29.3	27.0
"	10-25	63.9	21.2	68.8	53.4	56.0
"	25-40	66.7	31.6	71.2	45.9	66.0

Table 6.

Composition of soil microorganisms under winter wheat in experiments of Ivanov Station
(in % of total amount)

Experimental variations	Total amount of bacteria		Amount of fungi		Amount of denitrifyers	
	8 Sep. 1947	10 May 1948	8 Sep. 1947	10 May 1948	8 Sep. 1947	10 May 1948
No fertilizer	100	100	100	100	100	100
Manure under winter crops	76	110	152	68	310	470
Manure under beets	65	100	218	160	620	1150

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Table 7.

Effectiveness of aerobic and anaerobic manure (in c/ha) in experiments of the Ivanov Station

Crop	Years	Manure		Increase in favor of aerobic
		aerobic	anaerobic	
Yield of winter wheat	1946	11.6	10.5	1.1
	1947	30.3	25.4	4.9
	Average	20.9	17.9	3.0
Aftereffect on transplantings	1947	18.3	17.4	0.9
	1948	23.5	23.1	0.4
	Average	20.9	20.3	0.6
Aftereffect on Barley (second crop)	1948	16.4	15.1	1.3

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Ivanovskii, N. P.

Glaserit kok kaliinoe udobrenie pod tabak.

[Glaserite as a potassium fertilizer for tobacco]

Zemledelie, 6:65-67. Nov. 1955. 20 Z44

(In Russian)

Glaserite, a non-chlorous potassium fertilizer is effective under tobacco on fallow [zalezh']. The All-Union Scientific Research Institute for Tobacco and Makhorka conducted experiments with glaserite under vegetative and field conditions for several years. Four tables show the comparative results of glaserite, potassium sulfate and potassium chloride. Glaserite increase the yield and improves the quality of tobacco. It surpasses potassium sulfate in effectiveness.

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July 10, 1956

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Trans. A-710
(Abstract)
By: R. Adelman

Biriukova, V. S.

Khimicheskaia bor'ba s pyreem polzuchim.

[Chemical control of quack grass]

Les i Step', vol. 4, no. 12, pp:74. Dec. 1952. 99.8 L566

(In Russian)

The chemical preparations used in the control of quack-grass heretofore are 2,4-Dichlorophenoxyacetic acid (2,4-DU) and 2-methyl-4-Chlorophenoxyacetic acid (2M-4CH). The preparation isopropylether-phenylcarbamate (IEPhC or IPhC) has proved very effective for monocotyledons. After various experiments it was established that IEPhC eliminates quack-grass without injuring young trees, if applied 8-10 cm below ground. The experiments, however, are still in the initial stage and require further study before the herbicide can be used in shelter belts.

A 710

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Trans. A-711
(Abstract)
By: R. Adelman

Leshnev-Fin'kovskii, P.

V tekhnicheskom sovete ministerstva sel'skogo khoziaistva i zagogovok SSSR.

[At the Technical Council of the Ministry of Agriculture and Procurement of the USSR]

Zemledelie, 5:118-119. Aug. 1953. 20 2&4

(In Russian)

An article by Lysenko on "raising the productivity in the non-black soil belt" had brought a flood of inquiries from scientists and others concerning agro-technical principles of soil fertilization. The Technical Council of the Ministry of Agriculture arranged a meeting at which Lysenko and many others aired their views on organic and mineral fertilizers and on methods of their application. Some delegates felt, and Lysenko admitted, that his proposals needed further study and had to be tested under industrial conditions. The Technical Council voted for further test to be conducted at scientific institutions and on kolkhozes. The principle subjects were the application of superphosphate mixed with manure, and supplementary feeding with potassium and nitrogen fertilizers.

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Trans. A-712
(Abstract)
By: R. Adelman

Lysin, A. A.

Vliianie udobrenii na urozhai kartofelia

[Influence of fertilizers upon the yield of potatoes]

Sad i Ogorod, 8:74-75. Aug. 1951. 60 Sa15

(In Russian)

Data on the influence of manure and mineral fertilizers upon the yield of potatoes, cucumbers and tomatoes. The rate of mineral fertilizers producing increases is as follows: $N_{60}P_{90}K_{60}$ for potatoes, $N_{90}P_{90}K_{60}$ for cucumbers, $N_{60}P_{60}K_{60}$ for tomatoes; manure, 40 tons per hectare. The best results were obtained from a combination of manure and mineral fertilizers. Article has 5 tables citing experimental data for each of above crops.

Bezenchukskaia Selektsionno-Opytnaia Stantsiia.
Kyibshevskaia Oblast'.

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Translation A-713
(In full)
By: R. Adelman

Lipchinskii, K.V.

Vnekornevoe pitanie - velikaia sila dlia peredelki prirody rastenii.

[Stem injection feeding - a great force in the modification of the nature of plants]

Lesnoe Khoziaistvo, vol. 6, no. 6,
pp. 25-29
May 1962 99.8 L5622

(In Russian)

If conventional conditions of nutrition were altered and a plant were put on stem injection feeding, it would be possible to reconstruct the organism and to change the hereditary properties of seed. The plant does not care wherefrom and how its roots obtain ash elements and water. This fact has been known long since, thanks to Timiriazev's and Kostychev's experiments. Hence, by utilizing the suction power of the living plant organism, it can be fed artificially without the root system, and it can be grown according to one's own design.

In 1924, the Urman-Kudeisk forestry carried out artificial supplementary feeding of linden plantings. The application technique of stem injection feeding and the results of these experiments are as follows: through an aperture made at breast height with Pressler's increment gimlet, an iron tube curved at 45°, 1 dm in diameter, was

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injected into the sapwood of a tree. The tube was 1 arshin long [linear unit, 71.12 cm, 39-37 inches]. A solution derived from a mixture of magnesium chloride, potassium chloride, iron sulfate and calcium nitrate (5 gr. to 1 fourth of the vessel) was poured into it through a funnel.

Table 1.

Linden, common	Rate of growth in height, m		Rate of growth in diameter at breast height, cm		Rate of growth in diameter at collar of trunk cm [u sheikè]	
	Before experiment	After experiment	Before experiment	After experiment	Before experiment	After experiment
1. Control	13,8	14,0	12,40	12,45	13,25	13,65
2. Experiment	13,7	13,9	12,50	12,55	13,45	13,15
3. Control	13,9	14,0	12,30	12,40	12,90	13,20
4. Experiment	14,1	14,3	12,41	12,80	12,80	13,45
5. Control	13,9	14,2	12,60	12,65	13,10	13,30
6. Experiment	13,8	14,0	12,75	12,90	13,15	13,85

In analyzing the rate of growth in height and diameter it was established that the thickening of the annual increment had taken a divergent course. From the insertion of the tube at the collar the increment grew considerably larger; from the insertion of the tube at

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the top it became smaller. The yearly increment in height measures up to 20 cm.

The analysis showed that due to artificial supplementary feeding the tree trunks had become swell-butted. The thickening begins at the place where the tube is inserted, i.e. from breast height to the collar of the trunk. It was also clarified that the plant organism had reacted to artificial feeding not indifferently. The first day's absorption was energetic - one fourth of a bucket of mixture in three days, [Begin p. 24] then it slowed down and stopped.

After a few days it again became intensive but stopped completely after a rain.

A second experiment, conducted in 1926, was to locate the point of maximum tension of the suction power in the living organism in birch.

Iron tubes 1/4 to 1 dm. in diameter were inserted at different heights of the tree trunk: in three sample [model'nykh] trees of the 1st, 2nd and 3rd age classes - at breast height; in three sample trees of the 1st, 2nd and 3rd age classes - at the trunk collar; in three model trees of the 1st, 2nd and 3rd age classes - at the crown; in three sample trees of the 1st, 2nd and 3rd age classes - in the vigorous lateral [bokovye] roots. Water used in tests was free of nutritive salts. Absorption of the solution by the roots was noted in no case.

Results of the suction power of the living organism in a birch tree of the 1st age class, site class III, d=4cm, h=8.0 m, G=0.004 cub. m. are characterized in table 2.

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Table 2

Time	May 15	May 16	May 17	May 18	May 19	Total
			Infusion at collar, gr.			
In the morning.	-	115	109	106	99	429
At noon.	265	259	221	212	212	1119
In the evening.	267	292	256	221	217	1182
Total.	512	695	616	539	518	2750
			Infusion at breast height, gr.			
In the morning.	-	98	66	68	72	343
At noon.	119	108	102	99	91	619
In the evening.	122	117	114	105	97	555
Total.	241	323	302	292	260	1417
			Infusion in crown, gr.			
In the morning.	-	70	68	63	60	261
At noon.	78	80	79	74	71	382
In the evening.	82	83	91	82	79	417
Total.	160	233	238	219	210	1060

Results of suction power of the living organism in birch in the 2nd class, site class III, d=8 cm, h=12.0 m, G=0.029 cub. m, are characterized in table 3.

Results of suction power of the living organism in birch in the 3rd age class, site class III, d=12 cm, h=14.0 m, G=0.74 cub. m, are characterized in table 4.

From these tables it is evident that the maximum suction power of

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a birch organism is developed at the trunk collar and is completely absent from the roots. At the beginning suction proceeded intensively, but it became less active later on.

Further experiments investigating the influence of the root system upon stem injection feeding demonstrated that the older the age class, the less intensive is the suction when fed by stem injection.

In the process of observation, it was discovered that a sample birch had been chipped accidentally while going through the sight line [pri prokhozhdenii vizira] beneath the place where the feeding tube had been inserted at the crown. Water was exuding from this mechanical injury. When analogous injuries were inflicted on the rest of the sample trees, water exuded from their wounds also. This prompted the conclusion that: in the first place, a tree organism reacts rapidly to alien elements which enter it and that it isolates them between the bast and sapwood parts of the tree trunk, in the second place, the substances introduced by means of stem injection feeding higher than the collar do not at the beginning ascend to the crown, but descend to the trunk collar.

The third experiment was conducted in the red bilberry pine woods [v sosnovom brusnichnom boru] in the Turukhansk Territory. It involved establishing the location of the ascending currents in pine. The experiments were carried out by means of coloring the wood vessels with a chemical dye. After the nutrition tubes had been placed on the sample trees, the wood canals of the trunk appeared filled with

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resin. Absorption did not occur. Tapping was applied. At the height of 1 m from the trunk collar grooves were made 20 cm high, calculated to hold a 20 cm feeding belt between them. Two incisions each were made at once so as to open up the living cells produced at an 8-10 mm resin fissure [vrdymka] depth, at a 60-60° angle, after this the tree trunk was drilled to provide two through canals beneath the grooves near the collar. In one end was injected a 1 dm tube, the other three apertures were closed with corks. A 2% solution of acid salts stained with chemical ink was poured into the tube.

Table 3.

Time	May 15	May 16	May 17	May 18	May 19	Total
			Infusion at trunk collar, gr.			
In the morning. .	-	382	377	369	361	1489
At noon.....	292	389	385	378	355	1900
In the evening. .	416	413	408	401	398	2036
Total. .	807	1184	1170	1148	1115	4424
			Infusion at breast height, gr.			
In the morning. .	-	110	97	93	89	389
At noon.....	201	191	175	165	153	885
In the evening. .	297	281	269	253	249	1349
Total. .	498	582	539	511	491	2621

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Table 8 (con't.)

Time	May 15	May 16	May 17	May 18	May 19	Total
		Infusion in crown, gr.				
In the morning..	-	91	88	71	69	319
At noon.....	171	153	139	127	97	687
In the evening..	201	191	178	163	131	764
Total..	372	436	405	361	297	1870

Twenty four hours later there began an intensive exudation of resin which lasted for the duration of the test, approximately four days [96 hrs.]. The sample tree was sawed off and split into chunks [otrubki]. The wood was not stained.

The experiments were repeated with the sample tree being fed an added 2% solution of acid salts, later on, however, only stained water without acid salts. When the cut tree [khlyst] was sawed into 2-meter pieces, the wood of the first five pieces appeared slightly stained. Higher at the top it was not stained. It was visible from the butts that staining was occurring irregularly. Staining that is more visible (by the rings) occurs between the annual layers and fades toward the peripheral part of the trunk.

This experiment led to a new theme, namely: how much time does an organism require to raise water from the roots to the top, and how

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much water does the organism absorb? To ascertain this four sample trees had to be used: pine of the 1st site class, d=32, h=33, G=1.18 cub. m.

According to table 5, the greatest water absorption occurs when there are four canals, the water reaches the top on the fourth day. At the 30th meter of a lopped pine tree the amount of water absorbed is 462 kg, which constitutes 69.3% of the total amount of water occurring in the woody mass. Consequently, the water circulates in the organism continuously. Thus, stem injection feeding, i.e. absorption, cannot proceed periodically, which coincides with earlier observations. Hence, stem injection feeding is influenced by the force of osmotic pressure of the roots.

Table 4.

Time	May 15	May 16	May 17	May 18	May 19	Total
			Infusion at collar of trunk, gr			
In the morning..	-	486	477	453	439	1264
At noon.....	584	579	568	547	535	1811
In the evening..	695	681	679	622	617	5278
Total...	1279	1745	1718	1622	1579	6948
			Infusion at breast height, gr.			
In the morning..	-	389	377	368	334	1468
At noon.....	414	397	388	377	346	1923
In the evening..	497	486	475	455	403	2314
Total...	912	1272	1238	1200	1085	5705

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Table 4 (con't.)

Time	May 15	May 16	May 17	May 18	May 19	Total
			Infusion in crown, gr			
In the morning.	-	282	277	225	197	981
At noon.....	269	261	259	240	202	1431
In the evening.	301	297	266	251	209	1324
Total...	570	840	802	716	608	3736

The following experiments were to reveal the possible influence of stem injection feeding upon the biochemical processes occurring in the leaves and in the fruits of fruit trees. The peach, a fast-growing tree species which enters the fruition season early, was selected as the experimental object. After three generations, from the cultivated peach of the Elberta species was grown the seedling-wildling F-4 which produced small unsavory fruit. This seedling was nurtured by means of stem injection feeding. And here are the results obtained (table 6).

Table 6.

Duration of water infusion	Amount of water in sample trees, kg	1st sample tree (through 1 canal)		2nd sample tree (through 2 canals)		3rd sample tree (through 3 canals)		4th sample tree (through 4 canals	
		Water absorption, kg	Water movement from collar to top, m	Water absorption, kg	Water movement from collar to top, m	Water absorption, kg	Water movement from collar to top, m	Water absorption, kg	Water movement from collar to top, m
24 hours...	266,96	30	2,98	61	4,13	95	506	126	6,16
48 hours...	266,96	62	4,60	119	8,00	174	9,16	245	14,10
72 hours...	266,96	94	5,98	161	11,98	284	14,05	376	19,45
96 hours...	266,96	122	7,31	220	15,10	377	20,10	452	29.90

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Table 6.

Peach species and flower type	Seed and time of sowing	Time of flowering	Time of fruit ripening	Weight ratio of peel and stone in grams	Flavor properties and special characteristics of fruit.
"Elberta" small with dark-rose-colored petals	Grafted in 1926	May 1-5, 1930	August 5-7, 1930	3: 89: 8	Tasty, aromatic, pubescent. Stone separates readily from flesh. Rose-colored side.
Seedling F-1 Same	Seed "Elberta", Aug. 15, 1930	May 5-7 1934	August 6-9, 1934	3: 90: 8	Does not deviate from maternal species. Fruit 3/4 rose-colored.
Seedling F-2 Same	Seed of Seedling F-1 Aug. 15, 1934	May 6-8 1937	August 6-10, 1937	3: 81: 6.5	Flesh near stone is colored. Bitter aftertaste. Stone attached to flesh by thread-like fibrils. Rose coloring of fruit is slight.
Seedling F-3 Bigger, pale-rose petals	Seed of seedling F-2 Aug. 15, 1937	May 5-8 1940	September 2-7, 1940	2.5: 59: 9	Bitter, no rose coloring
Seedling F-4 Same	Seed of seedling F-3 Sept. 10, 1940	May 10, 1945	September 8-10, 1945	2: 58: 10	Bitter, unsavory. Stone clings to flesh. No rose coloring.
Seedling F-4 Same	Stem injection feeding from Apr. 28, 1945	May 2-4, 1946	August 2, 1946	8: 156: 10	Tasty, aromatic. Stone separates readily from flesh. Bright red.

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In the spring of 1946, when air temperature began to climb to 18° C, but soil temperature had only 3-4° of warmth, which is too low for the root system to create osmotic pressure, the necessary nutritive substances composed of mineral and organic elements were poured into the tree trunk. At first, two medullary rays situated opposite each other were determined near the trunk collar. In one of them a canal was drilled through the core of the tree to the bast part into an other medullary ray [serdtsevinnyi luch]. Opposite the other four medullary rays were cut vascular fiber fascicles found in the bast part. Then the modified "Forshstos" tube was inserted into the canal up to the sapwood of the tree.

The required amount of water and nutritive elements is calculated as follows: The mass of wood pulp of the broadleaf species contains 40.5% of water. My estimate of the weight of 1 cub. m. is 600 kg. The volume of experimental peach on mass at h=4.0 m, d=3.5 cm is calculated at 0.002 cub. m, or 12 kg in weight, 40.5% of which constitutes 4,86 kg of water. Such an amount of water should be expelled from the organism and replaced by a solution through stem injection feeding. The mixture is composed of 5% of mineral salts and up to 25% of organic elements. In the given case, the following dosage is desirable for experimental peaches:

Ammonium sulfate $(NH_4)_2SO_4$ .....8.1 gr

Potassium sulfate K_2SO_4 .....8.1 gr

Calcium nitrate $Ca(NO_3)_2$ .....8.1 gr

Sugar .....1.22 gr

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The weight of dry mixture was 1.463 kg, of water - 3.397 kg. The mixture was absorbed by the organism in two days [48 hrs].

Up to May 15th the peach tree was fed only water. From the 15th through the 31st of May the peach tree was fed additionally calcium nitrate and ammonium sulfate with sugar in the above proportions.

At blossoming time supplementary feeding with sugared water was administered for three days [72 hrs].

During this period the experimental peach was sharply distinguished from the control peach by its increment in diameter and height.

From the 1st through the 15th of June the experimental peach was fed a 5-percent mixture of magnesium chloride ($MgCl_2$), iron sulfate ($Fe_2(SO_4)_3$), and potassium sulfate.

From the 16th until the 30th of June, a total of 2.6% of citric acid and 0.8% of saccharine (crystallose) was injected into the organism.

From the 1st through the 15th of July, injections were administered of disodium hydrogen phosphate (Na_2HPO_4), magnesium chloride, and iron sulfate in 5% doses.

From the 15th through the 31st of July the experimental peach was fed only water and pantocite [pantotsit].

By August 1st the peaches were ripe and began to fill with juice. They were large, two-thirds colored a bright red, strongly pubescent, with a thick peel. The tasty, juicy and aromatic fruits weighed from 160 to 175 gr.

The fruit of the control peaches F-3 and F-4 began to ripen in September, the weight ratio of the fruit equalled 2 : 38 : 10 and 2.5: 59 : 9

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~~89:9~~. The fruit was bitter. The control peach "Pobeditel'" (from the early table varieties) had delicious fruit of good quality as always. The weight ratio of the fruit equalled 5: 96: 7. Ripening of fruit set in at the same time as in the experimental peach.

The experimental wildling peach F-4 (whose ancestors came from the cultural table varieties of the "Elberta" species) produced delicious, aromatic, pubescent fruits, rose-colored on the side, with a stone that separates readily from the flesh. The average weight ratio of the fruit equals 5: 89: 8.

In 1945, after several generations, the seedling F-4 produced unsavory bitter fruits that weighed 60 gr (2: 88: 10), and had a large stone and a poorly developed peel without any rose coloring.

This degeneration was caused by retarded formation of the fruit, under-development, thin peel and early disappearance of acid sharpness in unripe fruit.

To eliminate the deficiencies in fruit development caused by inadequate nutrition of the tree organism through the root system, I, at first, was impelled to apply nitrous elements for the development of fruit and young leaves. Afterward, in order to accomplish decomposition of albumin substances during hydrolytic processes, and to permit more nitrous substances to enter the fruit and stimulate its growth, their activity must be reduced by means of an aging process with the aid of phosphorus.

These two biochemical processes were regulated by nitrous substances with sugar, the latter being a growth stimulant.

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To reduce synthetic activity there was injected phosphorus (Na_2HPO_4), which, to be sure, does not enter into the composition of albumin substances, but as an ash element is the main component part of the cell nuclei of a developing seed. The growth of fruit flesh ceases when seed growth and formation ends, i.e. the division of cells stops and biochemical aging begins. [Begin p. 28]. Citric acid which I used as an organic element is of great importance. Unripe fruits always contain glyoxalic acid. The longer it is preserved, the bigger will be the fruit. The shortage of glyoxalic acid in unripe fruit induced me to apply its chemical equivalent - citric acid. During dissimilation citric acid, the same as glyoxalic, forms butyric acid esters [slozhnye efiry] in reacting to fructose, i.e. an important compound in obtaining high-grade aromatic peaches.

Saccharine was used not as a flavor element to increase the sweetness of fruit, but as an imid-orthosulfobenzoic acid which is bound with chlorophyll for the formation of cyanidine pigment and wax required for the development of fruit peel and the pellicle which forms on young vegetative organs. In the chemical analysis of peach fruits no saccharine was found in them.

Pantocite (referred to incorrectly as calcium hypochlorite mixture) was used as a disinfectant and as a catalyst in complex biochemical processes occurring in leaves.

Thus, stem injection feeding of the wildling peach F-4 with the indicated mineral and organic elements transformed the peach organism,

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changed its anatomical structure and chemical composition favoring desireable biological properties. The wildling which had produced unsavory bitter fruits weighing 50 gr, now yields excellent, tasty and aromatic fruits weighing from 150 to 170 gr.

In the fall of 1946, stones from the fruit of this peach were planted in the ground [grunt] and at present they produce excellent, large fruits. Only one of the seedlings is distinguished from its brothers by a beautifully formed ornamental crown with a profusion of leaves, yet its fruit is as small as that of the wildling and unsavory.

Stem injection feeding can be applied also to the transplantation of trees. Experiments were conducted on the 12-year old apple tree "Grushevka", and on 8-year old peach and apricot trees.

The transplantation of trees was carried out in the fall. When the root system was opened up, the Commission found a disparity between the root system and the surface part. This occurred on May 25. The trees displayed no signs of life. On the fifth day following the application of stem injection feeding the apple tree unfolded its leaves and blossomed out. The apple tree yielded delicious fruit of normal weight one month earlier than the year before, and produced over 400 fruit buds. New shoots grew up to 17 cm, and the diameter increment of the trunk reached 1.6 cm in one summer.

The transplanted peach of a cultural variety from the "Pavlia" group (pubescent, with a clinging stone) unfolded its leaves and blossomed out after it had been nurtured by stem injection feeding. On August 15 it produced tasty fruit of heavy weight. New shoots grew

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up to 95 cm. Increment in diameter reached 1.5 cm. The apricot tree unfolded its leaves after a single infusion of organic and mineral substances into its trunk, but it failed to blossom. This was due to the fact that, to test the effect of the stem injection feeding method, the nutritive substances had been removed from the mixture, the supplementary nutrition of the apricot had consisted of water. Leaf development ceased, and when the water diet was stopped - the apricot tree dried up.

When the apple tree "Grushevka" was transplanted, regulation of nutritive elements was accomplished by a similar method. When the apple tree was about to bloom the second time, a mixture was poured into its organism that consisted of 0.6% of salicylic acid, 0.6% of iron chloride, 0.25% menthol, and 0.10% of potassium iodide to 0.5 of a liter of water.

Salicylic acid and iron chloride had an influence upon the coloring of the fruit. Salicylic acid hindered the process of dissimilation. Menthol eliminated irritation of the points of growth. Potassium iodide was used as a conductor of nutritive salts into the organism (it does not serve as a nutritive element). Iodine tincture with menthol cause gum exudation, while potassium iodide with menthol produces no such phenomena.

Injection of iodine was due to the fact that in prolonged application of stem injection feeding the wood cells in the wound through which the absorption proceeds become "dull", i.e. barriers form in the

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cells. First I simply widened the wound by cutting off [srezom] the old wood, but this resulted in severe illness of the plant. The wound failed to heal for a long time. When I began to use iodine, these phenomena were no longer observed.

Influence of nutritive substances upon the plant at various stages of its development was used to eliminate periodicity of fruition in fruit trees. In April, when the soil was not yet sufficiently warm and water was evaporating through the surface part of an apple tree in transpiration, I accomplished an infusion on the apple tree "Zolotoi ranet" that consisted of [the following] components to 0.6 liter of water:

Magnesium chloride $MgCl_2$	0.25 gr
Potassium chloride KCl	0.25 gr
Potassium sulfate K_2SO_4	0.5 gr
Ammonium sulfate $(NH_4)_2SO_4$	0.5 gr
Calcium nitrate $Ca(SO_3)_2$	0.5 gr
Oxalic acid	0.01 gr
Potassium iodide	0.10 gr

The apple tree was fed this compound by the stem injection method until July while the peel of the fruit was young and green, i.e. while the growth processes were taking place.

Later, from July until the second stirring of juice [sokodvizhenie] the apple tree was fed disodium hydrogen [dvukhzameshchennym] phosphate, sugar and saccharine. Fruit began to ripen in August - one month earlier than the usual time. When the yield was gathered, the apple tree produced new, normally developed fruit buds.

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After the application of stem injection feeding, the apple tree brought an abundant yield for a period of three years, but in the fall of 1950 there were considerably less fruit buds on the apple tree than before. This prompted the hypothesis that due to a food shortage in the soil, the root system was once again reconstructing the tree organism for the former physiological processes.

When the soil is not moistened naturally, then stem injection feeding of aqueous solutions influences the organism and compels it to adapt itself to new nutritive conditions. When soils are moistened naturally, then stem injection feeding of aqueous solutions has little effect. Hence, in areas where soils lack natural moisture, stem injection feeding of aqueous solutions is of great importance.

When there is sufficient soil moisture, stem injection feeding can be applied with dry elements. In 1948, stem injection feeding with dry elements was applied to peach. The calculated dose of nutritive salts was pressed into the shape of a cylindrical tablet (pill) and inserted into the canal made at the trunk collar of the peach tree. The soil under the peach was regularly irrigated. In August, this tree produced fruit of various sizes. On the southern side of the crown the fruit was large, but on the northern side of the crown it was small, as usual. The amount of fruit was the same on either side of the crown. This is explained by the fact that at the time the canals were drilled through the first medullary ray, there was no second medullary ray in the tree. This induced me to change the technique of stem injection feeding for tree species, to make it more specific and effective, i.e.

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to inject the preparations into each medullary ray so as to exert influence upon the root system by violation of its ascending current vessels. This is done as follows: on the peripheral part of the tree trunk the number of medullary rays present near the trunk collar is calculated by the presence of the vigorous roots, and a canal is drilled in each ray up to the dead cells of the wood (but not as far as the core).

The method of stem injection feeding has a great future. Its use is desirable in forestry in the production of new forms of woody plant species.

RA/BN

July 19, 1956

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Transl. A - 714
(In full)
By: V. Makarenko

Ponomarchuk, M.K.

Rozh'

(Rye)

In Za vysokie urozhai zernovikh kul'tur, p. 319 - 323.
Moskva, Sel'khozgiz, 1955. 59 2 14

(In Russian)

Rye is most widely spread in central regions of the Russian Federation, in lands along the Volga, in northern and north-west regions of Ukrainian SSR and in Byelorussian SSR. Here, as in other regions of the country, winter varieties of rye are cultivated, which have high and stable yielding capacity and a larger grain.

Rye is, after wheat, the most important grain food crop. In recent years rye occupies an ever larger place in the feed balance. By planting winter rye many leading kolkhozes and sovkhozes get their earliest green feed for cattle.

Spring rye is but negligibly spread and is cultivated primarily in those regions where the growing of winter rye is extremely difficult on account of severe winter conditions and not enough snow. Such are some regions of eastern Siberia and of Transbaikal.

Winter rye is a high-yielding crop. Leading farms of the country, under diverse conditions, obtain from year to year high yields of rye, 20 or more centners per hectare. Thus, a kolkhoz "Krasnoe znamia", in David - Gorodskii raion, Brestskaia oblast' of Byelorussian SSR, in 1953, obtained 20.1 c/ha of winter rye from its whole planted area.

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Rye, in this kolkhoz, was sowed after potatoes, which were planted on a clean fallow. Thirty tons, per hectare, of peat-manure compost were introduced under potatoes. The planting was done (begin page 320) immediately after harvesting the potatoes and harrowing of the field. In the early spring, superphosphate in a dose of 1.5 c, and potassium chloride at 1 c per hectare was applied as top dressing for plants in the fields sowed to rye.

In order to conserve the moisture, to remove dead leaves, and to increase the access of air into the soil, harrowing of the sowing was done in two "sleda" (gangs). During blooming of rye the kolkhoz carried out a supplementary artificial repollination.

A kolkhoz "Komintern" of Mogilevskii rayon, Mogilevskaia oblast' in Byelorussian SSR is obtaining considerable yields of winter rye on sandy soils. This kolkhoz plants winter rye after a lupine fallow. As a rule, the sowing is done with high quality seeds, always in a narrow-row manner, with a norm of 2 c/ha. Granulated superphosphate, 0.5 c/ha, is applied simultaneously with the seeds. During the blooming period of rye a twofold supplementary artificial pollination is carried out. Owing to such measures, the yield of winter rye comprised, as an average for two years (1952 - 1953), 19.6 c per hectare.

A still higher yield was obtained by kolkhoz "Novaia zhizn'" of Verkhne-Mullinskii raion of Molotovskaia oblast'. From an area of 169 hectares they harvested, in 1953, 20.3 c/ha. When turning the fallow, the kolkhoz applied to most of the area up to 30 t of manure and up to 3 tons of lime per hectare, and phosphorite meal, calculating about 0.5 t per h to the whole area.

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The rules of agrotechnics are adhered to very rigidly in the kolkhoz. Only high quality locally regionalized variety Viatka of winter rye seeds are sowed. An artificial, supplementary pollination is always conducted during blooming. A leading experience of one of the kolkhoz brigades speaks about a possibility of obtaining here still higher yields of winter rye. A yield of 27.5 c/ha was obtained by a brigade, whose leader was a Hero of Socialistic Labor Z. O. Maklanova. This brigade was the first to do liming of the soil. Besides this, compared to other brigades, they, somewhat, increased the dose of fertilizers.

Effectiveness of liming is also attested by the experience of Kolkhoz "imeni Molotova" of Nerekhtskii raion, Kostromskaia oblast', whose turf-podzolic soils have an increased acidity. As far back as in 1948, the first tillage brigade of this kolkhoz applied 3 t/ha (begin page 321) of lime tuff and obtained an increase in yield of 4 c/ha of winter crops. Basing themselves on this experience, the kolkhoz began to yearly increase the area for liming the soil.

Liming, together with other agrotechnical measures, sharply increased the yielding capacity of grain crops in the kolkhoz. Thus the yield of winter rye and wheat was increased from 8 - 12 to 20 - 25 c/ha. The yielding capacity of other crops increased also.

The lime tuff is prepared in spring, summer and fall, and is removed to the fallow; it is piled in small heaps of 2 - 4 cartloads. The tuff is uniformly distributed over the field before ploving in a norm of 3 - 5 t/ha, depending on the acidity of the soil. The degree of acidity is established by an analysis of the soil, as well as by observation of the behavior of plants. If, for instance, clover grows badly on a

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fertilized field, if its leaves become yellow, and it is in a state of depression, whereas the weeds, especially such as sheep sorrel, horsetail, and others develop well, this means that the soil has surplus acidity and needs large doses of lime. Liming is done by the kolkhoz on the fallow, simultaneously with a deepening of the plow layer and applying at the same time manure and peat. Besides this, in order to enrich the soil by phosphorus, the kolkhoz, when turning the fallow, applies phosphorite meal in a norm of 0.8 to 0.9 t/ha. The kolkhoz began the joint application of organic and mineral fertilizers already in 1953. This same first tillage brigade applied at that time for winter wheat to each hectare, 4 - 5 centners of compost, 8 c of phosporite meal, 2 c of superphosphate and 1.5 c of potassium. In 1954 a yield of 18.4 c/ha of winter wheat was obtained by the kolkhoz, regardless of unfavorable climatic conditions.

All these measures help considerably in the increase of yielding capacity. But the effectiveness could be higher, if the kolkhoz would organize a composting of manure and peat with lime and phosphorite meal.

In the dry conditions of the lands along the Volga, a kolkhoz "imeni Stalina" of Molotovsky raion, Kuibishevskaia oblast', obtained, in 1953, 23.4 c per hectare from an area of 601 hectares; and one of the brigades harvested 26.4 c per/ha from an area of 210 hectares. (Begin p. 332)

Smyshliaevskaia MTS (machine and tractor station), which is servicing this kolkhoz, holds that the row crops are exceptionally important, as with their help a considerable accumulation of moisture in the soil is achieved, which is especially necessary under conditions of this zone.

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Winter rye is planted here on black fallow. As the weeds come up, the fallow is cultivated with a simultaneous harrowing. Twenty to twenty-five days before sowing the winter rye, sunflowers are planted on the fallow by a two - row band method, with a norm of 4 kg per ha, and at a distance between the rows of links of 10.5 meters, and between the lines 15 cm. Rye is sown across the links, covered to the proper depth, and at the best possible agrotechnical period for planting. Toward winter the row crops achieve a height of more than a meter, which helps in the formation of a snow covering in a layer of 40 - 50 cm. In order to guarantee a high yield, the kolkhoz applies an early-spring top dressing of superphosphate in a dose of 1 c/ha to the winter rye and harrows the plantings in two gangs. Only high-quality seeds of the new high-yielding and winterhardy Volzhanka variety of winter rye, which was developed by the Institute of Agriculture of South-East, was utilized for the plantings.

It is necessary to note, that in the zone of the Smyshliaevskaia MTS other kolkhozes besides the kolkhoz "imeni Stalina" obtain high yields of winter rye. The yield of winter rye in kolkhozes, which are serviced by this MTS in 1953 comprised, on the average, 18.7 c/ha.

Of great interest is the leading experience of kolkhozes which are serviced by Zakhal'skaia MTS in Irkutskaia oblast'. Up to 1948, these kolkhozes obtained, on the average, 6 - 7 c/ha of grain crops. And now they grow, under severe conditions of Siberia a high yield of grain crops, especially of winter rye. In recent years, in the zone of MTS the yield of winter rye comprised on the average 16-18 c/ha. In some kolkhozes the yield of this crop was even higher. Thus, in a kolkhoz

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"imeni Zhdanova" 20 c/ha were obtained, in kolkhoz "imeni Mikoiana" 24 c/ha.

With the aid of MTS in kolkhozes the fallow wedge was widened considerably; the cultivation of soil has improved sharply; the leading methods of agrotechnics are utilized ever wider. About (begin p. 323) 50 per cent of the whole planted area of grain crops is planted by crossover and narrow-row methods. As the weeds come up; the fallows are cultivated at the proper time. The yearly mean of rainfall here is only 320 - 350 mm. In their fight to accumulate moisture; the kolkhozes provided for the retention of snow; also did the early-spring harrowing of the plowland and of plantings of winter rye. A top dressing for plants on sowings of winter rye is applied in the early spring, and during the blooming; an additional artificial repollination is done. Only the high-quality; well prepared seeds are used. They are subjected here to air-heat warming. Many kolkhozes are creating transitory seed funds, and plant winter rye with the seeds of the past year's yield.

In recent years the Zakhal'skaia MTS, according to agreement with kolkhozes is bringing under cultivation new lands, which were not yet utilized; and obtains from them high yields. The yields on these lands, on the average for 1952 and 1953, comprised (in centners per hectare): in winter rye 25.6, in spring wheat 25.4 and in millet 31.3.

The experience of the Zakhal'skaia MTSand of kolkhozes; in the zone serviced by this station, graphically shows, that in the severe conditions of Siberia, with prolonged and very cold winters; when temperature in winter reaches 40 - 45 degrees of cold, it is possible to obtain high and stable yields of winter rye.

VM/JM

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Translation A-715
(In full)
By: R. Adelman

A 715

Rodionov, A.P.

Selektsionnaia rabota s plodivymi i
iagodnymi rasteniiami na Ukraine.

[Selection work with fruit and berry
plants in the Ukraine.]

Akad. Nauk SSSR. Izvestiia, Ser. Biol.,
no. 4, pp. 3-13. July/Aug., 1955. 511 Sa2B

(In Russian)

The output of farm labor and the productivity of cultural plants can be increased only if the varietal composition is good.

I. V. Michurin attached exceptionally great importance to the development of new plant varieties: "Whether we are dealing with grain and technical crops, or with fruit and berry plants - we must concentrate all our mental faculties and physical strength on the development of new varieties which will answer more fully industrial and export objectives and the objectives of an improved national diet" (Michurin, 1939). His teaching concerning directed variation opened up possibilities for creative guidance of the development of plant and animal organisms, of planned evolution of new forms with desirable characteristics. I. V. Michurin's new varieties have gained widespread distribution. In the Ukraine, in the orchards of kolkhozes and sovkhozes, on plots owned by kolkhozniks, laborers and office personnel adjacent to farmhouses, there are growing 584 thousand plants of the Michurin apple variety "Penin shafrannyi", 91 thousand plants of the pear "Bere simniaia Michurina", 56 thousand plants of the plum "Renklod kolkhoznyi".

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In addition, a large number of other Michurin varieties are under cultivation: Bel'fler-kitaika, Slavianka, Renklod reforma, Plodorodnaia Michurina [Michurin's fruitful one].

Selection of fruit and berry crops in the Ukraine bore the influence of I.V. Michurin's teaching. His stressing the great importance of selection work to the State, and the need for zoning in the development of new varieties laid the foundation for the establishment and distribution of scientific-research institutions in the Ukraine.

Ivan Vladimirovich watched carefully the work of selectioners and lent them the support of his own authority. In the salutory telegram "Kolkhoznoe selo" sent to the editor's office (1934) he wrote: "to direct special attention to the preservation of several hundred hybrids developed by the selectioner, L'vov Mihailovich Ro, at Mleevo which are of enormous importance to the State" (Michurin, 1939).

The repeated appeals addressed by Ivan Vladimirovich to scientific workers, researchers, kolkhozniks and laborers of the Ukraine have contributed to the development of science and practical fruit culture.

Selectioners of the Ukraine owe the positive results which they have attained solely to the method of hybridization and directed rearing developed by I.V. Michurin.

Systematic work for the development of new fruit and berry varieties in the Ukraine was begun in Soviet time. In the prerevolutionary period only small scale, single projects were conducted by individual scientists and practicing horticulturists (C.F. Chernenko, N.F. Kashchenko, I.Ia. Magomet, L.P. Simirenko, Krasovskii and others). Their valuable beginnings, however, like those of other individual selectioners who worked under the conditions

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of czarist Russia, received no State support and remained the private affair of the originators themselves. In this respect, the selection activity of S.F. Chernenko is significant. Having worked since 1902 in one of the northern regions of the Ukraine, [Begin p. 4] he finished his basic works only in the postrevolutionary period, and by 1925 developed 16 winter hardy apple varieties. At the present time S.F. Chernenko's varieties (Pepin Chernenko, Diana, Antonovka novaia and others) have been incorporated in the standard assortments of many republics, regions and territories.

Of great importance to Ukrainian fruit culture are the well-known works of N.F. Kashchenko, I.Ia. Magomet and L.P. Simirenko.

The initial work of developing new varieties in the Ukraine after the Great October Socialist Revolution is connected with the organization in 1921 of the Mieevo Experimental Station - one of the first scientific-research institutions for fruit culture in the Ukrainian SSR. A little later there were established the Ukrainian Scientific-Research Institute for Fruit culture and the Melitopol Experimental Station (1930), the Crimean Experimental Station, the Krasnokutsk Base [opornyi punkt] (1925), and the Donets Base (1936).

Apart from the system of the Ukrainian Institute for Fruit Culture, selection work in fruit culture is carried on also by the Nikitsk Botanical Garden (Crimea-Yalta), the Botanical Garden of the Academy of Sciences, Ukrainian SSR (Kiev), the Botanical Garden of the Nezhin Pedinstitute (Nezhin, Chernigov Region), Uman Agricultural Institute (Uman, Cherkassy Region), Kroshnensk Agricultural Technicurn (Zhitomir - Kroshnia) and others. Successful work is being done by the Michurinite experimenters A.A. Shchegliuk,

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P.T. Kaliushnyi, S.E. Kisel' and others.

As a result of many years of work, selectioners have developed about 450 new forms, 121 of which have been accepted as new varieties for the regionalized assortment of the Ukrainian SSR alone. The hybrid stock created within the system of the Ukrainian Institute for Fruit Culture, numbering 72,297 fruit plants, 7968 plants of bush fruit, and 18,230 plants of the strawberry, is very valuable in the development of new, high-grade varieties (tables 1, 2, and 3).

Table 1.

Number of new fruit and berry plant varieties accepted for the regionalized assortment of the Ukrainian SSR

Institutions and Michurinite experimenters	Number of varieties per crop													
	Apple	Pear	Plum (Prunus)	Plum (Prunus divaricata)	Cherry (Prunus cerasus)	Cherry (Cerasus avium)	Apricot	Peach	Strawberry	Raspberry	Currant	Gooseberry	Almond	Total
Ukrainian Scien.-Res. Institute for Fruit culture.....	7	-	-	-	-	6	5	4	3	1	-	-	-	24
Mleevo Experimental Station.....	12	4	2	-	-	5	-	-	1	1	2	2	-	29
Melitopol Experimental Station..	-	-	-	-	1	6	-	-	2	-	-	1	-	10
Crimean Experimental Station.....	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Donets base.....	7	4	-	-	1	-	-	-	-	-	-	-	-	12
Krasnokutsk base..	5	-	-	-	-	-	-	-	-	-	-	-	-	5
Nikitsk Botanical Garden.....	-	-	2	6	-	6	1	12	-	-	-	-	3	30
Botanical Garden Acad. Scien. USSR	-	-	-	-	-	-	1	6	-	-	-	-	-	7
Skvir Experimental field.....	-	-	1	-	-	-	-	-	1	-	-	-	-	2
Shchegliuk, A.A...	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Total.....	32	8	5	6	2	24	5	22	7	2	2	3	3	121

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In the Ukraine the leading institution in the sphere of fruit and berry plant selection is the Ukrainian Scientific-Research Institute for Fruit Culture. Those directly subordinate to it are the Mleevo, Melitopol and Crimean experimental stations, and the Donets and Krasnokutsk bases. [Begin p. 5]. It directs all experimental work in fruit culture as it pertains to methods. Here are worked out the basic methodical problems of developing new varieties evolving Michurin's teaching concerning directed variability.

As a result of experiments, the vernalization phase in fruit plants has been established by using the peach and the sand cherry as an example, which has created new possibilities for directed formation of winter hardiness. It has been clarified that the peach and the sand cherry are capable of passing the vernalization phase within the seed which contain all the required plastic substances, and that under specific external conditions the vernalization phase passes unimpeded.

The peach and sand cherry are capable of passing the vernalization phase also at the time of seed stratification. As regards developmental and fruition characters, plants grown from stratified seed are similar to seedlings obtained from vernalized seed.

The sand cherry can pass the vernalization phase in the spring at the time of seeding under field conditions at a comparatively high temperature. Plants from vernalized seed, however, produce a yield 2.9--5.7 times larger than that of seedlings obtained from dry seed. If seeding is done in May when the low temperatures of early spring no longer occur, then the differences in productivity grow accordingly up to 6.25 times.

The morphological characters which indicate that the vernalization stage

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Table 2.

Number of new varieties and anticipated number of fruit and berry plants undergoing State variety tests in the Ukrainian SSR

Institutions and Michurinite experimenters	Number of varieties and number per species												
	apple	pear	plum	cherry [Prunus cerasus]	cherry [Cerasus avium]	apricot	peach	strawberry	raspberry	currant	gooseberry	plum [Prunus divaricata]	Total
Ukranian Scien.-Res. Institute of Fruit Culture	32	3	4	1	28	10	7	16	7	4	3	--	115
Mleevo Experimental Station	38	26	10	2	18	--	--	1	3	5	4	--	107
Melitopol Experimental Station	--	2	4	1	20	--	--	10	--	--	4	--	41
Crimean Experimental Station	10	1	--	--	--	--	--	--	--	--	--	--	11
Donets Base	34	10	--	2	--	--	--	--	--	--	--	--	46
Krasnokutsk Base	13	1	--	--	--	--	--	--	--	--	--	--	14
Nikitsk Botanical Garden	--	--	4	--	20	13	36	--	--	--	--	21	94
Botanical Garden of Nezhin Pedinstitute	--	--	--	--	--	7	--	--	--	--	--	--	7
Skvir Experimental field	1	--	1	1	--	--	--	1	--	--	--	--	4
Babenko, V.M.	1	--	1	--	--	--	--	--	--	--	--	--	2
Shchegliuk, A.A.	--	--	--	--	5	--	--	--	--	--	--	--	5
Kaliushnyi, P.T.	--	--	--	--	--	2	--	--	--	--	--	--	2
Kondratenko	--	--	--	1	--	--	--	--	--	--	--	--	1
Cherniavskii	--	--	--	1	--	--	--	--	--	--	--	--	1
Total	129	43	24	9	91	52	43	28	10	9	11	21	450

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has not been completed are rosette clusters [rozetochnost'], poor growth of the central shoot, and bushiness.

In addition to the first stage, fruit plants have also other stages of development which have not yet been investigated. For instance, one-year old peach plants grown from unstratified seed begin to develop after the pattern of vernalised plants when they have overwintered in an open plot, but they still are a whole month late in forming flower buds, as compared to plants from stratified seed. This can be explained only by the fact that they spend part of the vegetative season passing through subsequent stages, [Begin p. 6], while the plants from stratified seed are completely ready to bear fruit in the very first year (fig. 1, 2, 3 and f).

Stages of development are fundamental regularities in the life of plants. Unless they are studied, it is impossible to direct creatively the development of new varieties. Even though characters and properties have their own (private) regularities, their formation, in many respects, is determined by the phasic status of the organism. Depending on the passing of some phases and on the conditions of their passing, the plant makes different demands of environmental conditions, and forms its own characters variously.

Physiological processes which characterize the individual development of plants can manifest themselves also in morphological characters. The establishment of a correlative relationship between them presents much scientific and practical interest. The more accessible morphological indicators can be controlled more easily during the development of seedlings which are under the influence of diverse cultural conditions, and during the propagation of new varieties.

It is characteristic of young seedlings of cultivated pear varieties to

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Table 5.

Hybrid stock of fruit and berry crops of the Ukrainian Institute of Fruit Culture and its experimental stations and bases in 1955

Institutions	Fruit crops							Bush fruits				
	Apple	Pear	Plum	Cherry: Prunus cerasus and Cerasus avium	Apricot	Peach	Total fruit	raspberry	Currant	Gooseberry	Total	Strawberry
Ukrainian Institute of Fruit Culture.	6,860	3,610	122	1,544	177	620	13,153	257	965	218	1,430	11,750
Mleevo Experimental Station.....	15,396	2,982	1,452	2,291	-	-	20,120	920	3,658	710	5,188	-
Melitopol Experimental Station...	2,800	2,200	1,200	2,800	2,500	-	11,500	200	-	400	600	2,500
Crimean Experimental Station.....	3,600	4,050	37	-	-	46	7,933	-	-	-	-	2,000
Donets Base.....	6,000	2,000	3,000	550	1,500	250	13,300	-	450	300	750	22,000
Krasnokutsk Base...	5,617	694	-	-	-	-	6,311	-	-	-	-	-
Total.....	38,472	15,536	5,811	7,185	4,177	1,116	72,297	1,377	4,983	1,628	7,968	18,250

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transform some twigs into thorns. This characteristic is one of the morphological indicators of the freshness of seedling tissue and of the demonstration degree of cultural characters.

The period of improvement of vegetative organs of seedlings from the wild type to the cultural form depends on individual characteristics as well as on conditions of development. Poor conditions of nutrition inhibit change in morphological characters intrinsic in young seedlings.

Twigs on the same plant may find themselves under different nutritional conditions, as a result of which there emerge different properties even in tissues of the same age.

The seed of fruit plants are not perfect at the moment the fruit turns ripe: some of them germinate poorly (apple tree), others produce externally normal seedlings, but of very low winter hardiness (peach) [Begin p. 7]. To enable seed to acquire the properties inherent in their nature, certain changes must occur within them to complete their development. A study of these changes and of the conditions required for their occurence will make it possible to guide this process in the desired direction.

Investigations conducted have shown that a series of structural transformations (formation of procambium, vessels) which determine subsequent normal plant development occur within the embryo of an apple seed during its pre-seeding preparation.

Fig. 1. Peach tree from stratified seed in the third year of its life. Produced an average of 201 fruits per plant.

Results of experiments have demonstrated also that during this period the conditions of embryo development exert a strong influence upon the formation of winter hardiness in seedlings. Thus, 80.2% of the seedlings of the

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Renet Simirenko apple grown from seed which had remained within the fruit until the end of December and afterward had been left dry, had overwintered, while seedlings obtained from seed that had remained within fruit up to the time of seeding had overwintered only 2.6%.

To develop winter hardy varieties of southern plants, I. V. Michurin recommended that their seed be planted later in the season so as to enable them to sprout when it is already warm (Michurin, 1939).

T. D. Lysenko established in his works (1952) that the formation of resistance to the rigors of winter in annual plants is a result of their assimilation of autumn conditions while passing the vernalization phase.

Experiments with peaches have demonstrated that the phasic status is of essential importance in the formation of winter hardiness in woody plants. Seedlings grown from unvernalized seed, and especially from partly vernalized, [Begin p. 9] acquire a higher degree of winter hardiness as compared with plants from seed that had passed the vernalization phase prior to seeding.

Fig. 2. Peach from unstratified seed in the third year of its life. After overwintering at the age of one year it began to develop after the pattern of vernalized plants, but it was a month late in the formation of flower buds. The lag in development can, obviously, be explained by the fact that part of the vegetative period passed while the plant was going through other phases. It produced an average of five fruits per plant.

Fig. 3. Peach from stratified seed in the fourth year of its life.

Fig. 4. Peach from unstratified seed in the fourth year of life. As to degree of flowering, it no longer differs from the plants obtained from stratified seed.

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However, a higher degree of winter hardiness is not determined by the phasic status alone. It is merely a factor required to create a certain capacity of the organism to assimilate external conditions. Unvernalised plants have a better opportunity to assimilate environmental conditions and to change accordingly. However, whether these conditions will promote or tend to decrease winter hardiness depends on their nature, and results obtained in the same phasic status may vary. For instance, in experiments in summer planting of peaches it was noted that unvernalised seedlings possessed higher winter hardiness if the fall was dry and cold. During a warm and humid fall with a large number of overcast days, plants thus prepared were, on the contrary, injured worse than vernalised seedlings.

Therefore the experiments clarify not only the phasic status in which the plant is better able to form high winter resistance, but also the conditions needed to create this property.

Breeding new varieties in a shorter space of time is one of the most important tasks of selectioners.

According to data of the Mleevo Experimental Station only 49% of hybrid apple seedlings begin to bear fruit in the 20th year of their lives. The hybrid seedlings of pears start bearing fruit even later. At the present time many investigators have demonstrated that the cause of such late fruition is not the nature of the fruit plant, but the method used in selection work.

Phasic aptitude for bearing fruit is acquired by fruit plants very early. It is known that hybrid seedlings of pears and cherries form flower buds at the age of two, the seedlings of apples and apricots at the age of one. On the strength of this, even a slight improvement in the method of growing hybrid plants hastens the time of fruit-bearing. For example, in

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growing apple seedlings with one transplantation instead of two, practiced by the conventional method, many plants began to bear fruit in the fourth year. [Begin p. 10]. If peach is grafted with germinating seed it begins to bear fruit abundantly on the third year of life, yet when grown on its own roots without being transplanted - on the fourth year, and upon transplantation - on the fifth to sixth year.

In 1954, the Selection Department of the Institute initiated an extensive experiment in growing hybrid apple seedlings in a permanent place without transplantation, and with the subsequent use of a directing [nastavochnogo] mentor in the form of the old early fruit-bearing varieties.

Concurrently with the further development of the selection method the Institute is conducting practical breeding of apple, pear, peach, apricot and strawberry varieties for the districts of Poles'e [Forest area] and eastern Lesostep' [Forest Steppe]. In the past there had been created 116 new forms of fruit and berry plants, 24 of which have been added to the regionalized assortment as new varieties; the rest are undergoing State and industrial tests (see tables 1 and 2).

The more valuable varieties are:

the Kievskaia ranniaia-2 strawberry; it ripens 5-7 days earlier than the old varieties, opening the marketing season for fresh fruit and berries;

the Korallovaia-32 and Korallobaia-100 strawberries; the berries of these varieties are 2-3 times larger than those of the older, more widely distributed Koralka variety, and they produce a higher yield;

the peaches Kievskii rannii and Kievskii-1792; these possess a considerably higher winter hardiness as compared with the old varieties; they

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survive 30° frosts and produce a good yield.

The Mlesvo Experimental Station is the oldest experimental institution of fruit culture in the Ukraine. It enjoys well deserved renown far beyond the borders of the republic. The station's nursery releases yearly a large quantity of high-grade planting material of diverse varieties. Most of the variety-testing and pomological orchards are cropped with saplings grown at the station. It has the very best collection of fruit plants. One of the first-class apple varieties of the world assortment, Renet Simirenko, came from Mlesvo.

Selectioners of the Mlesvo Station are busy breeding new varieties of apples, pears, the cherries Prunus cerasus and Cerasus avium, plums, currants, gooseberries and raspberries for the districts of western Lesostep'. They have developed 107 new forms of fruit and berry plants, 29 of which have been added to the regionalized assortment (see tables 1 and 2).

The more valuable winter apple varieties are: Mlesvskaia krasavitsa, Novogodnee, Lesostepnoe, Zinnee, Renet Nikonenko. They possess a high degree of winter hardiness with good dessert fruit properties.

In addition to practical selection at the station, a series of methodical problems is being resolved: "Study of mentor influence upon the formation of characters in hybrids of apples, pears and plums", "Study of the nature of Sphaerotheca [parasitic fungus] resistance and development of methods for obtaining Sphaerotheca resistant gooseberry varieties", "Development of methods for obtaining thornless gooseberry varieties."

The Melitopol Experimental Station is known for its cherries [Cerasus avium]. They are the best varieties in the Soviet Union and are exported to

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the most important centers in the country: Moscow, Leningrad, Kiev, etc.

The Station is busy developing new varieties of Cerasus avium, apricots, apples, pears, strawberries, raspberries and gooseberries. In past years 41 new forms were created: 10 have been added to the assortment as varieties and 31 are undergoing State and industrial testing (see tables 1 and 2).

The best among them are the new varieties of Cerasus avium: Skorospelka and Dneprovka. The first ripens almost simultaneously with the old variety of Ranniaia marka, but it possesses larger and better fruits.

The most interesting of the questions dealing with methods which occupy selectioners at the Melitopol Station are "Development of methods for the production of viable seedlings of early cherry varieties" [Begin p. 11] and "Acceleration of fruit-bearing of hybrid seedlings."

The Crimean Experimental Station became part of the system of the Ukrainian Scientific-Research Institute for Fruit Culture in 1954, after the Crimean Region was annexed to the Ukraine. Up to that time it was part of the system of the Michurin Institute. Its work is apple and pear selection.

As irrigation expands in the Crimea, the area under fruit and berry plantings will be further increased chiefly in the interest of the steppe and foothill districts. Conditions in this part of the Crimea are radically different from those of the coastal zone and they call for other, more winter hardy varieties. Concomitantly with selection from the existing assortment, serious attention is paid also to creating new varieties adapted to local climatic conditions. At present the Station has bred and is testing 11 forms of apples and pears (see tables 1 and 2).

The Donets Base serves the severest zone in the Ukraine. An arid summer and severe frosts in the winter - those are its characteristics. Only a small

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part of the old varieties can be grown under these conditions without a risk, yet even these lose their inherent properties: they become insipid and incapable of survival if left lying for any length of time. Hence, the fundamental task of selectioners at this base is to create new high-grade varieties, well adapted to the soil and climatic conditions in the Donets Basin. Work is being done to breed new varieties of apples, pears, plums, cherries, peaches, gooseberries and black currants.

Of the 46 new forms of fruit plants bred, 12 have been approved for the assortment (see tables 1 and 2). The most promising new variety is Slava Donbassa. An apple tree that ripens in winter time and bears fruit with excellent flavor properties, survives the severe climatic conditions of North-Eastern Ukraine considerably better than the old varieties.

The Krasnokutsk Base is engaged in developing new apple and pear varieties for the north-eastern districts of Lesostep'.

Selectioners have obtained 14 new forms of apples 6 of which have been added to the regionalized assortment (see table 1 and 2).

The best variety is Renet Krasnokutskii. This variety ripens in winter time and has excellent flavor properties; it possesses a higher degree of winter resistance compared with the standard varieties of this zone.

The Nikitsk Botanical Garden is breeding new varieties of peach, apricot, plum [Prunus divaricata], cherries, subtropical fruits and nuts for the Crimea and other southern regions of the USSR. The basic trend with regard to stone fruit is to obtain canning varieties which ripen at various times, with regard to subtropical crops, it is to develop varieties with winter hardiness.

Since the work began the new forms obtained number 100 stone fruits and

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40 subtropical and nut fruits. Of this amount 30 varieties have been regionalized in the Ukraine (see tables 1 and 2), a portion of the varieties has been included in assortments of other republics.

The Selection Department carries on interesting methodical work pertaining to the study of the period of dormancy in peach and apricot; this work is of great importance in the selection of parent pairs to be used in breeding new varieties with a long and deep dormancy period.

The Cytology Laboratory has developed a method for growing seedlings of early peach varieties which is already being applied to selection work.

The Botanical Garden of the Academy of Sciences, Ukrainian SSR, is conducting work to create new varieties of peach and other stone fruits for the districts of Poles'e and Lesostep' of the Ukrainian SSR.

Continuing the work begun by Academician N.F. Kashchenko at the botanical Acclimatization Garden [b. Akklimatsad], selectioners have brought out 11 new peach and apricot forms, 7 of which have been accepted for the regionalized assortment.

[Begin p. 12]. The best peach varieties selected by the Botanical Garden are Slava Kieva and Polesskii.

The Skvir Experimental Field; here the laureate of the Stalin award, Iosif Iakovlevich Magomet, one of the oldest selectioners of the Ukraine, is working. In January of 1955 he was 75 years old. Concomitantly with his basic work - selection and seed growing for vegetable crops - he is engaged also in breeding new varieties of fruit and berry plants. His best varieties - the strawberry Iosif Magomet and the plum Stakhanovka - have received wide distribution in Ukrainian gardens. One apple variety and one cherry variety are undergoing State variety testing.

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The Botanical Garden of the Nezhin Pedinstitute: selection work is aimed chiefly at breeding new apricot varieties for the northern regions of the Ukraine.

The 7 new forms obtained have been accepted for State variety testing; special attention among them is due Nezhinskii-1, Nezhinskii-7, and Nezhinskii-11.

The Kroshnenskii Sel'skokhoziaistvennyi Tekhnikum (Zhitomir). The technicum instructor, M.M. Fedorenko, together with his students, members of the Michurin circle, have been breeding new varieties of apples, apricots and peaches for Polesie since 1956. The more than 30 new forms obtained are now undergoing further study. Much interest, with regard to winter hardiness, is presented by the peaches No. 9 and 17 and by the creeping [stelliushchiesia] forms of the apricot.

Breeding of new varieties of fruit and berry plants is conducted also by Michurinite amateurs in conjunction with scientific research institutes and educational institutions.

One of the oldest Michurinites is A.A. Shchegliuk (kolkhoz imeni Lenina Zhitomir Region). He has been working at selection since 1925. He has bred many interesting forms of cherry, apple, pear and other plants. Five new cherry forms are undergoing State testing, one of them - Krasavitsa Chernialkhova - has been added to the regionalized assortment.

Interesting work is being done by the horticulturist of the kolkhoz imeni Il'icha (Poltava Region), M.G. Gorisdra. By means of hybridisation and the use of the mentor, he strives to develop a high-grade apple variety that will ripen in the winter.

The railroad pensioner S.E. Kisel' (Poltava) has bred his own forms by planting Kiev peaches; they recieved a good rating at the regional agricultural

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exhibition.

S. I. Shishko (village B. Kokhnovka in the Poltava Region) has a remarkable collection of gooseberries (152 varieties). An ardent selectioner, he strives to improve every plant.

In the Sumy Region (kolkhoz imeni 1 Maia) I. P. Tkachev is working as a horticulturist. He tends to the orchard and at the same time breeds new varieties. A late ripening apple hybrid which he obtained has been accepted by the State Commission for testing in the Sumy, Chernigov and Zhitomir Regions.

Michurinite P. T. Kaliushnyi (Chernigov Region) is known for his northern apricots (Sribnianskii No. 4 and Sribnianskii No. 1). Along with fruit plants, he grows also subtropical plants.

New varieties developed by selectioner-fruit growers are beginning to play a notable role in orchard planting of the Ukraine.

In kolkhoz and sovkhoz orchards and on plots owned by kolkhozniks, laborers, and employees near farmhouses, the varieties derived from the apple tree Zelenka dneprovskaia number 104 thousand plants, from Osennee zolotoe - 105 thousand, Kal'vil' Mleevskii - 46 thousand, the varieties of the cherry Melitopol'skaia ranniaia - 49 thousand, of the peach Kievskii rannii - 9 thousand, of the plum Stakhanovka - 8 thousand plants, of the raspberry Kitaevskaia - 10 ha.

The new strawberry varieties Kievskaia panniaia-2, Korallovaia-32 and Korallovaia-100 occupy leading positions in the plantings near Kiev. They are grown on 24 kolkhozes and sovkhozes on an area exceeding 42 ha.

The maternal stock of the new varieties bred by the Institute constitutes 52,854 plants of woody species, 49,280 plants of bush fruits and more than 42 ha of strawberries.

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The Mleevo Experimental Station has grown in its nursery over 168 thousand saplings of new fruit varieties and 76 thousand of bush fruits. At present, the Station's new varieties are growing on kolkhozes and sovkhozes in 20 regions of the Ukrainian SSR on an area of more than 1000 ha.

New cherry varieties of the Melitopol Experimental Station have been propagated and turned over to production in the amount of approximately 20 thousand plants.

In 1965 the system of the Ukrainian Institute of Fruit Culture plans to release to kolkhozes and sovkhozes planting material of new varieties - 35,600 plants of the pome species, 64,900 of stone fruits, 9100 plants of bush fruits and 645 thousand bushes [flientsev] of strawberries.

Right now selectioners are facing the task of improving their work qualitatively, of creating high-grade varieties with more winter hardiness within a short space of time. This will require further creative development of Michurin's teaching, discovery and investigation of new developmental regularities of plant organisms, and final eradication of the deficits and dogmatism in selection work.

Selectioners must view their work critically, they must definitely rid themselves of the spirit of self-conceit and must always remember that the strength of science lies only in progress. We must follow the covenant of our teacher, Ivan Vladimirovich Michurin. In his declining years he wrote: "I see clearly and believe firmly that all is contained in movement, and I never console myself with what has been attained before me or during my time, nor with the success achieved by myself" (Michurin, 1939).

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By: V. Makarenko

A 716

Cherniavskaia, Z.S.

Selektsiia prosa

[Selection of millet]

In Khar'kovskaia Gosudarstvennaia Selektsionnaia Stantsiia. Selektsiia i semenovodstvo zernovykh kul'tur, p. 91 - 99. Moskva, Sel'khozgiz, 1953. 69 K522

(In Russian)

A variety of millet, Kharkovskoe 436 (a variant of Aureum), was developed as a result of selection work in previous years by a method of mass selection; it is regionalized in Kharkovskaia, Poltavskaia, Voroshilovogradskaia, Odesskaia and Issyk-Kul'skaia oblast'. For the last five years (1946 - 1950) a variety Kharkovskoe 740 stood out in the yield of grain during the station variety test; it was developed by a method of individual selection from a variety Veselopodolianskoe 367. Variety Khar'kovskoe 740 gave a higher yield by 2.99 c/ha, or by 11.2%, and in 1950 by 2.7 c/ha, or by 7.8% more, compared to the variety Khar'kovskoe 436. Surpassing by variety Khar'kovskoe 740 of the variety Veselopodolianskoe 367 for three years comprised 3.6%, and for 1950 3.36%. According to data of interstation variety tests in 1948, and in 1949 on Mironovskoi Government Selection Station, Khar'kovskoe 740 variety surpassed the standard Khar'kovskoe 436 by 10.6%, having a larger seed and a smaller percentage of pellicles.

In 1950, according to data of Merchanskii Agricultural Technical

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School of Bogodukhovskii raion, Khar'kovskaia oblast', the Khar'kobskoe 740 variety gave a yield surpassing the standard Khar'kovskoe 436 by 5.01 c/ha in a production test (on an area of 1 ha).

The quality of grain of the 740 variety compared to varieties 367 and 436 is given in table 1.

TABLE 1

CHEMICAL COMPOSITION OF MILLET (ACCORDING TO VARIETIES)

VARIETIES	% of protein				% of fat			
	1947	1949	1950	Average 3 years	1947	1949	1950	Average 3 years
Veselopodolianskoe 367	18.7	14.4	14.3	15.8	6.3	3.0	4.7	4.7
Khar'kovskoe 436	18.5	15.9	10.2	14.9	6.4	2.8	4.8	4.7
Khar'kovskoe 740	15.8	15.3	10.0	13.7	6.5	3.4	5.0	5.0

(Begin page 92)

A first place in the contents of protein belongs to variety Veselopodolianskoe 367; and in the contents of fat the first place goes to Khar'kovskoe 740.

Aims of selection. The Station aimed to develop varieties which will surpass in yielding capacity the regionalized ones. The new varieties must possess high qualities - large size of grain, thin pellicles, panicle must retain well the ripe seeds, must have non-brittle panicles and a straw resistant to lodging.

In view of a large diversity of varieties of millet according to

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color, to cooking qualities of the kernel and to taste, during the process of selection work consideration was also taken of: the percentage content of protein and of fat in millet; the speed of its cooking; color of the kernel; volume obtained when cooked; tasting qualities of the cooked product.

Methods of work. For a basic method of selection the following was adopted:

a) individual and mass selection of samples of initial material from regionalized varieties, and utilization of natural hybrids of millets;

b) intravarietal hybridization with a free elective pollination by means of planting prospective varieties of millet in alternate rows with regionalized varieties.

Critical period in the development of millet. It is customary to divide the vegetative period in two parts - from seedling to panicle formation, and from panicle formation to ripening. The second part of the vegetative period is the most crucial, as from the moment of the formation of panicles almost simultaneously begins the blooming and the formation of grains, in tiers, in panicles. Under conditions of the Khar'kov Station the panicle formation, in most varieties, proceeds during the second decade of July. One must consider the rain, which is falling before or during the period of formation of panicles, as a deciding factor in affecting the yield of millet. We cite table 2 to show the character of influence of meteorological conditions on the development of millet for the last five years.

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TABLE 2

INFLUENCE OF MET OROLOGICAL CONDITIONS ON THE YIELD OF MILLET, VARIETY KHARKOVSKOE 436

YEARS	Yield (in c/ha)	Rainfall (in mm)			Mean temperature of air (in °)		
		V	VI	VII	V	VI	VII
1946	20.0	8.1	2.5	149.9	16.8	23.9	20.8
1947	20.8	90.3	25.7	34.1	17.3	20.2	21.9
1948	28.8	58.8	37.2	137.2	17.7	22.1	19.2
1949	18.5	1.9	138.2	73.1	18.7	17.5	19.8
1950	34.5	15.5	92.1	91.4	15.9	17.9	19.5
Perennial		48.9	66.9	66.5	15.4	18.8	20.9
Average yield	24.5						

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Title of: Figure 1 - Development of millet during a dry period - June 22, 1946.

Figure 2 - Development of millet after an insignificant rainfall.

In May and June of 1946, there was only 10.6 mm of rainfall, while the several years' average for these months is 115.6 mm. At the same time north-east or south-east dry winds were predominant.

Temperature of the air for June was 6.3° higher than the average for many years. Maximum temperature on the surface of the soil rose to 40 - 46°. In spite of this, at first the plants developed well, there were no yellow leaves even in the lower tier, although the root system was very weak. (Figure 1)

The plants had only one primary rootlet. The secondary roots were in an embryonic stage, in the form of small tubercles or rootlets not longer than 0.5 cm long. After an insignificant rainfall (July 4 - 3.4 mm and July 5 - 3.6 mm) began a fast formation of secondary millet roots; up to 30 strong, well developed rootlets have formed (Figure 2.)

One should note, that the rain, which fell on July 4th and 5th, moistened only the upper layer of the soil. That is why the development of the root system stopped. The strong rootlets produced a matted filament out of thin root hairs. In consequence of the dry weather the plants began to suffer from the lack of moisture (Figure 3). Their leaves curled, became yellow, and partly dried out. The plantings were almost ruined. The rain that fell on July 12, and on subsequent days, produced a favorable influence on the plantings and provided a harvest of grains

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up to 20 c/ha. (Begin page 94)

Title of Figure 3 - The state in which the plants were on July 9, 1946.

The next year, 1947, must also be held as unfavorable in meteorological conditions for the growth and development of millet, with only the one difference, that in 1946 the long dryness was before the beginning of panicle formation, and in 1947 - after the beginning of panicle formation, but the rain that fell in the second decade of July has remedied the situation. Yield of grain in 1947 was 20.8 c/ha. On the basis of the cited observations one can make a conclusion, that millet is an exclusively drought - resisting crop, which can tolerate sharp fluctuations in climatic conditions and give stable yields of grain and straw.

The following years - 1948, 1949 and 1950 - should be regarded as favorable for millet. It is also necessary to take into consideration that the agrotechnics for millet plantings were very high on the station during all the years.

A lowering of the yield in 1949 occured on account of a partial damage to the sowings by plant lice. In 1950 the yield of millet, after an alfalfa crop, was 35-40 c/ha.

Initial material. The Station had in all worked through about 2000 samples of millet from the Ukraine and from other allied republics (Central Asiatic, Transcaucasian and Kazakh SSR), as well as samples of unknown origin.

Diversity of form and of ecological types represents a considerable interest for the selection work.

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Characteristics, according to varieties, are fluctuating in very wide limits; thus fluctuations were from 45 to 110 days on the length of the vegetative period; on the height of plants from 35 to 172 cm; on the yield of grain from a plot(4 sq. m.) from 15 g to 1.25 cm; on absolute weight of grain from 5.2 to 12.0 g. The best material in the yield of grain was tested in the control nursery and in a preliminary variety test. (Begin page 95)

Besides the variety Khar'kovskoe 740, the following varieties are of interest in economically valuable characteristics: 2307, 2534; 2696; 300.

The three first varieties are of hybrid origin, whose parental forms are described in the section "Natural Hybrids." Data of yields and quality of grain of above-cited varieties are given in table 3.

Results of variety tests of millets have shown that all the potential varieties, large-grained, with thin pellicles, have surpassed in the yield of grain, the standard Khar'kovskoe in 1949 by 18 - 26%. On the average for 2 years from 4 to 15%.

Experience of work in recent years allows to make a conclusion that a method of individual selection and of repeated mass selection is not enough for obtaining new varieties with high yields. We used a method of hybridization with a free pollination, as well as utilized the natural hybrids.

Artificial hybridization. The economic characteristics of parental forms are very important for the use of artificial hybridization

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in selection work. Also their biological peculiarities, especially the coincidence of panicle formation and of the blooming of spikes. Differences in the length of the vegetative period of millet varieties are very great. Thus, the early maturing varieties (Kramoiarskie) under conditions of Khar'kovskaia Station ripen in 45 days, panicle formation and blooming occur for them in the month of June, and the length of blooming is 3 days; the lately-ripening (Far Eastern samples) are not able to finish the panicle formation before the beginning of first autumn frosts. The upper and the middle parts of the panicle are the most valuable for artificial hybridisation. The lower tier usually blooms less heavily and has many weak, underdeveloped seeds.

Work in emasculation of millet flowers is made very complicated by the small size of the flower and its fragile attachment to the pedicle. Observations of the process of blooming of the panicle from the moment of the beginning of its formation and of the state of the flowers in different stages of their development have made it possible to make more precise the process of mass emasculation of millet flowers at the moment of opening of the flower and, without mechanical injuries to the flower pellicles.

Observations of the blooming of millet on Chakinskaia Gosselkstantsia (Governm. Select. Station) during 1935 - 1937 and in Khar'kovskaia Station in 1944- 1947 have shown that millets begin to bloom approximately from 8 - 9 o'clock in the morning, when the temperature of the air is 16 - 18° C and the weather is clear. When the temperature of the air was 25°C and over on the Chakinskaia station of Tambovskii oblast', no blooming was noticed, while on Khar'kovskaia Government

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Selection Station the blooming of millet continued at temperatures above 30°.

During gloomy, cool and cloudy weather the blooming of millets was not observed either on Khar'kovskaia or on Chakinskaia stations.

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Table 3

VARIETIES	Yield of grain (by years) in c/ha					Average yield	in % to the standard		Quality of grain							
	1946	1947	1948	1949	1950		1949	1950	Average for 2 years	% of protein Average for 3 years	% of fat Average for 3 years	% of pellicles 1949	% of pellicles 1950	Average for 2 years	(in g) Wt. of 1000 grains 1949	(in g) Wt. of 1000 grains 1950	Average for 2 years
Khar'kovskoe 436 Standard	20.0	20.8	28.8	18.6	34.3	24.5	100	100	100	14.87	4.68	13.2	14.4	13.8	7.6	7.4	7.4
Khar'kovskoe 740	22.8	22.5	31.5	23.7	37.0	27.5	128	108	118	13.72	5.00	13.4	12.7	13.0	7.6	7.5	7.54
" 436	-	-	-	20.1	34.3	27.2	100	100	100	-	-						
" 2307	-	-	-	23.9	37.5	30.7	119	107	113	-	-	14.3	11.5	12.9	7.6	7.8	7.69
" 436	-	-	-	20.1	34.3	27.2	100	100	100	-	-						
" 2534	-	-	-	23.8	35.0	29.4	118	100	109	-	-	16.2	12.8	14.5	7.8	7.5	7.68
" 436	-	-	-	20.1	34.3	27.2	100	100	100	-	-						
" 300	-	-	-	25.6	36.1	30.8	127	103	115	-	-	16.3	13.3	14.8	7.4	7.06	7.23
" 436	-	-	-	20.1	34.3	27.2	100	100	100	-	-						
											-	13.1	15.3	14.2	7.5	7.3	7.37

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By: V. Nakarenko

(Begin page 97)

During observations of millet blooming under conditions of Khar'kovskaia Station in 1947 new facts were established, namely: regionalized varieties: Nos. 436, 367, 997, 198, 24/273, 215, 3965, 653 and Gul'denskoe 10, were planted at a later period (2nd half of June). For the crossing, especially, the phases of development were shortened and particularly so the time of panicle formation. Their intensive blooming occured under different conditions, than with the usual time of planting(sowing during the 2nd half of May). Their blooming was recorded during low temperatures of air and during cloudy and windy weather, which was never observed with normal times of sowing.

The regionalized varieties and varieties, which give high yields, Khar'kovskoe 436, Veselopodolianskoe 367, Khar'kovskoe 642, Chakinskoe 3985 and 997, the Voronež Agricultural Institute 198, and others were used for obtaining many artificial hybrids. These varieties were sowed in alternating rows; emasculation of individual plants and flowers was carried out, marking them off with a tag, but no isolators were used. The plants were left to pollinate freely.

Natural hybrids. A former statement that millet is a strict self-pollinator finds a refutation. In practice it is ascertained, that the presence of natural hybrids in plantings of millet is a frequent occurence. Thus, in 1944, in plantings of millet, variety Khar'kovskoe 436, we have found plants which were typical for this variety in the form of panicle and in grain, with a well expressed anthocyan coloring not only on the spike's pellicle and on the panicle, but also on the upper

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By: V. Makarenko

leaves of the plants.

In 1945 the plants, which were grown from seeds of every one of the selected hybrid panicles, showed segregation in the shape of the panicle (from the branchy to the compact) with different variations in the length of the panicle.

As a result of detailed study of hybrids one can assume that one of the parents was the regionalized variety Podolianskoe 24/273, which is characterised by a branchy panicle with an anthocyan coloring; it was grown for several years by the Station. The length of the panicle of this variety is 25 - 30 cm; the color of the grain is yellow; absolute weight is 6 - 6.5 g; form of the grain is elongated, oval; variety has coarse pellicles; height of the plant is 75 - 85 cm; vegetative period runs for 80 - 85 days; the straw is fine, of good fodder quality.

The above cited features of variety Podolianskoe 24/273 were found in progenies of natural hybrids in various combinations with characteristics of the maternal variety, which, as noted earlier, was the Khar'kovskoe 436 variety, having a compact panicle, 20 - 25 cm in length: Its grain is large, round, has thin pellicles, is of cream color (absolute weight of 1000 grains is 7.6 - 8.2 g). Output of millet grains is good- 83 - 86%. The height of plants is 85 - 95 cm. In its vegetative period it is middle lately ripening (85 to 90 days). Straw is not brittle, panicle retains the ripe grain very well. (Begin page 98)

In natural hybrids the features of both of these varieties were especially clearly expressed in 1945 in the progeny of one panicle of hybrid origin, which was isolated in 1944 from the planting of Khar'kovskoe 436 variety.

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Trans. A. - 716
(In full)
By: V. Nakarenko

At this, the preponderance of features of variety 24/273, a variant of Subfliavum, was noted in the progeny of the plants, especially in the shape and coloring of the panicle.

In 1945, from the second generation of the panicle of the type 24/273 subfliavum, 95 highly productive plants were separated; from among them 24 plants with an Aureum panicle, of a type Khar'kovskoe 436, with an anthocyan coloring and without anthocyan, and 69 plants with a branchy panicle of a type 24/273 Subfliavum with anthocyan and without.

Among hybrids, which were selected for the planting in 1947 as the most productive ones, predominate panicles of the branchy form, with large grains of rounded shape, of cream coloring.

The character of the new forms, which were obtained as a result of utilization of natural hybridization of millet in comparison with the parental varieties, is given in table 4.

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CHARACTER OF NATURAL HYBRIDS OF MILLET

TABLE 3

SORT	VARIETY	HEIGHT OF PLANTS (in cm)	NUMBER OF INTERNODES	LENGTH OF PANICLES (in cm)	WEIGHT OF 1000 GRAINS (in g)	WEIGHT OF YIELD FROM A PANICLE (in g)
436	AUREUM	85 - 95	6 - 7	22 - 26	7.6 - 8.2	3.6 - 7.5
24/273	SUBFLIAVUM	75 - 85	5 - 6	25 - 30	6.0 - 6.5	
HYBRIDS	AUREUM WITH ANTHOCYAN AND WITHOUT	88 - 125	4 - 7	21 - 33	6.6 - 9.0	3.3 - 7.6
*	FLIAVUM WITH ANTHOCYAN AND WITHOUT	84 - 133	4 - 6	23 - 38	6.25 - 6.8	

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The hybrid plants stood out sharply in the height of plants and in the vigor of the panicle.

From the 1947 yield, the hybrid items, which were selected for the sowing in 1948, were characterised by high productiveness of the panicle and the yield of grain, the weight of 1000 grains was 6.6 - 7.2 g. The botanical composition of hybrids - Subflavum, Subaureum. Anthocyan is well expressed in panicles and in upper leaves of the plant. The grain, in most cases, has a dark cream color. The straw is strong, thin, high. The panicle has seeds that do not fall out.

In subsequent years the varieties of hybrid origin 2307, 2534, 2696, which surpassed the standard in yield of grain by 4.75 to 12.95%, on the average for 3 years of tests (see table 3), were brought to the competitive variety test.

CONCLUSIONS

1. The Station tested about 2000 samples of different varieties of millet, which are characterised by a diversity of forms and of ecological types, and which are very important for the selection work.

2. An observation of the biology of blooming of millet was conducted and a process of artificial hybridization was developed. It was established that in order to evade the possibility of separating the flower from the pedicle, the emasculation of millet must be conducted during the beginning of the opening of the flower.

3. The natural millet hybrids were widely utilized in the selection work, and the result of this was, that potential varieties 2307 and 2534 were obtained.

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Trans. A - 716
(In full)
By: V. Makarenko

4. In 1929 the Khar'kovskaia Station had developed and regionalized the Khar'kovskoe 435 variety of millet. In recent years (from 1944 to 1950) such potential varieties as Khar'kovskoe 740, Khar'kovskoe 2307 and Khar'kovskoe 2534 have been developed. From among these, the variety Khar'kovskoe 740 was passed on to the kolkhozes for production evaluation.

VM/JM
July 25, 1956

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Translation A-717
(In full)
By: V. Ilkovenko

Krasnik, A.A.

Selektsiia i semenovodstvo ozimoi rzhi.

[Breeding and seed raising of winter rye.]

Zemledelie, no. 1, pp. 60-63, 1955. 20 Z56

(In Russian)

A 717

Varieties of winter rye Saratovskaia 1 and Volshanka, which were bred by the Agricultural Institute of South-Eastern USSR, occupy two million hectares of the acreage under crops. At that, Volshanka, as the more highly yielding variety, in recent years is being more widely regionalized in many oblast' of the South-East, displacing Saratovskaia 1 and many other varieties.

Variety Volshanka was bred by the method of individual selection from local Eliseevskaia rye, during a natural repollination of it with other varieties as follows. Eliseevskaia rye was sown around other varieties in the course of several years. As a result of repollination, the rich hybrid material of Eliseevskaia rye was obtained.

At the same time individual selection of the best hybrid generations was done and in the following years they were cultivated under the best possible conditions. The best of them were harvested and threshed, each individually. From among the seeds, the best were again selected and planted under field conditions, and a natural pollination of hybrids repeatedly carried out by the mixture of the most diverse rye pollen.

Finally, from generations which had the best economically useful properties the best seeds were selected and their yield was put together. The lot of seeds

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thus obtained, served as an initial one for the breeding of the winter rye variety Volzhanka. In the following years this variety was propagated, improved and tested under production conditions. We do not give any data on the Volzhanka yield compared to Saratovskaia 1, because it has already been published several times.

In order to obtain a still higher yield and a high-quality variety of winter rye the Institute has been working, during recent years, on the creation of a large-grained rye. One should note here that all the previously bred varieties of winter rye in the south-east have comparatively small grains.

Yet, it would be incorrect to try to breed a variety of rye of a type like "petkuss" (of western origin) with an absolute weight of seeds of 40-50 g, because the conditions of the land along the Volga differ considerably from the conditions of Poles'e. For the lands along the Volga it is characteristic, as a rule, to have insufficient rainfall and that is why the ripening of grain here is relatively restricted. Besides this, the biology of development of a rye plant is characterized by several peculiarities. Starting in spring this crop develops very well, gives a rich vegetative mass, and then begins to suffer from the insufficiency of moisture in the soil; the result of this is that the grain becomes small and often undersized.

That is why it is necessary to somewhat remake the type of the rye plant, striving at the same time to increase the size of the grains. In our opinion, under conditions of the south-east it is possible and necessary to create such a variety of winter (Begin p. 81) rye, which, together with other good economic indicators, would also have an absolute weight of the grain of 50 g.

And this means one should obtain at least 10 g more for this indicator, which fact will certainly be reflected in the yielding capacity of the variety.

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A success in the selection of agricultural plants, as it is known, is determined by the selection of the initial material, by the training of plants and by the methods of selection.

Taking into account the established rules of rye's conduct during a foreign pollination, including also the influence of large grain size on the small grain size, we think that it is necessary to have for selection, on the one hand, a group of large-grain varieties of winter rye and, on the other hand, the best regionalized selection variety.

As supplemental material confirming the mutual influence of the different size of grains during repollination, we could cite much factual data-- and not from our own observations alone.

As the size of a journal article is very limited, we shall quote only certain parts of the Institute's data which were obtained by the aspirant M.M. Milukov. (table 1).

Table 1.

Crosses	Weight of 1000 seeds of the maternal variety before crossings (g)	1952	
		Yield of grain (c/ha)	Weight of 1000 grains (g)
Small-grain X large-grain[1]...	10	19.0	11.6
Large-grain[1] X small-grain ...	46	19.2	12.8
Large-grain[1] X large-grain[2]..	45	23.2	16.6

(1) Germanskaia belozernaia (German white-grained)
(2) Bel'giiskaia zelenozernaia (Belgian green-grained)

For this experiment, as a small-grained rye we took Buriat-Mongol original greengrained rye from the world collection. The large-grained forms

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also represent original samples of rye from the world collection. Hybrids shown in table 1 were repollinated in the course of two years.

From table 1 it is seen, that the yield of grain of repollinated samples is 4 c per ha higher in that case where the small-grained rye did not take part in repollination. Yet, on the whole, decrease in the size of grain was produced by climatic influence during ripening of grains (lack of rains, high air temperature).

Data of another test on the influence of large-grain size on the small-grain size are very interesting, where the initial original varieties of winter rye were planted in pairs in alternating rows on area-isolated plots. During blooming there occurred a natural repollination. Besides this, here was utilized an additional artificial pollination by the method of A. S. Musiiko.

In those cases when one of the components of interbreeding was lagging in development (Zhitkinskii rye), from the second component (Volzhanka) the initial stalks were removed during the heading stage. As a result of this we obtained a large initial hybrid material, which in 1952/53 was studied in variety-tests (table 2).

It is seen from table 2, that the small-grained varieties of winter rye, after repollination with large-grained, give a higher yield with a good quality of grain. (Begin p. 82)

On the contrary, when large-grained varieties are pollinated by small-grained, they noticeably decrease the yielding capacity and the absolute weight of the grain. This is especially noticed, when initial varieties are sharp biotypes. Zhitkinskaia rye, as it is known, is a very small-grained variety. That is why after repollination with Volzhanka it considerably increased the yielding capacity (by 4.6 c per ha), as well as also the absolute weight of

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Table 2

Variety and hybrid	Reproduction of seeds	Weight of 1000 grains (g)	Yield of grain (c/ha)
Volzhanka	Original	12.9	11.4
Volzhanka X Vesele-Podolianskaia.	Repollinated 1 year	13.9	13.8
Vesele-Podolianskaia X Volzhanka.	The same	12.2	11.2
Vesele-Podolianskaia.....	Original	15.1	10.8
Zhitkinskaia	"	7.5	5.3
Zhitkinskaia X Volzhanka.....	Repollinated 1 year	9.2	9.9
Volzhanka X Zhitkinskaia	"	12.0	10.6

the grain.

Thus, during hybridization the large size of the grain is of great importance.

Yet one should note, that one cannot explain the increase in yield from repollination merely by an influence of the large size of the grain of the other component. It is known, that repollination, especially with a proper selection of components, increases the vitality of the hybrid plant — winter hardiness is improved, as well as the productive bushiness, and other properties, which are positively reflected in the yielding capacity of the variety. (Begin p. 83)

The problem of importance of the large grain size during foreign pollination was also studied by M.M. Miliukov, and also on samples of rye from the world collection (table 5).

Thus, in this experiment also, when small-grained varieties were repollinated in mass, their absolute weight increased also, whereas in large-grained

(sentence continues after table 3)

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Table 5.

Where the seeds came from	Weight of 1000 grains (g)				
	Seeds obtained from VIR	Original seeds of Saratovski reproduction, yield of 1951	Repollinated seeds in the first year (yield of 1951)	Repollinated seeds in the second year (yield of 1952)	Repollinated seeds in the third year (yield of 1953)
From:		Small-grain varieties			
Rostov oblast'.....	33.0	16.9	19.5	27.0	-
Sverdlovsk oblast'.....	20.0	17.6	22.6	29.2	20.7
Krasnoiarski krai.....	20.0	18.3	21.7	29.1	19.6
Chitinskaia oblast'	20.0	17.3	24.0	29.8	-
Arkhangel'skaia oblast'.	19.7	16.6	18.6	28.2	23.9
		Large-grain varieties			
Poland	40	32.6	23.4	31.4	22.4
Belgium.....	45	30.2	27.5	30.7	23.6
Czechoslovakia.....	40	28.7	21.6	31.7	23.7
Lithuanian SSR.....	40	29.0	26.4	29.1	-
BSSR.....	45	28.0	25.6	21.1	-

varieties it decreased, especially during the first year after repollination. In the following years a return to the large size of the grain was noted in the hybrid seeds.

This is the general rule in the conduct of hybrids concerning the size of grains during their mass repollination. In cases of successful selection of components for interbreeding the effectiveness of this method will be much higher.

Fig. 1 Winter rye of the Volshanka variety.

Fig. 2 Type of a selected plant of a large-grained rye.

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Observations of many authors testify about this, including also our work on the selection of winter rye. On the basis of the above said, we took, as initial material in selection for development of large-grained rye, a group of large-grained varieties from the world collection (Begin p. 84) and the regionalised variety Volshanka. The planting was done in the field in alternating rows. A large number of hybrid forms from each kind of the initial materials was obtained as the result of this. The selection of best plants was done in the field on the standing grain, during the wax stage, taking into account the vigor of the plant's development, its resistance to lodging, the alignment of its stalks, size, form and number of grains in the spike, the tightness of seed coats, and other properties. Such selected plants were marked by binding a twine around it, and then were uprooted separately.

In the laboratory they were checked again and only the best ones were threshed. After that followed a rigid sorting of each grain separately. Finally, for the planting only those progenies were selected which had an absolute weight of grains not less than 40 g (not quite thoroughly sorted). As during the first years there were only a few such plants, the progenies with smaller grains were utilized, but only these which were well filled out. Using repeated selection in the course of several years, and training hybrid plants under conditions of high agrotechnics, we achieved some successes; in the selection nursery for rye, in 1954, on an area of 1 ha were planted progenies with an absolute weight of grain 42 g, and over. In individual cases the weight of 1000 grains attained 50 g and over.

Titles of :
Fig. 3. Spikes of large-grained winter rye.

Fig. 4. Large-grained winter rye.

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The obtained material, selected for the large size of grain, and for several other economically useful qualities, presents an important value for selection, (Begin p. 86) although for the retention of these qualities very painstaking work will be required in the future.

For a production test of the obtained results in this stage of selection work, we set up complex hybrid populations under the name of large-grained rye, which in the following years were studied under production conditions of Kolkhozes, on fields of the Institute, and in the State variety test network. Thus, a Kolkhoz "Parizhskaia Komuna" of Borisovskii raion, Belgorodski oblast' by planting the large-sized rye, has obtained in the course of three years a yield, which is much higher than the regionalized varieties. Thus, in 1953, on an area of 2 ha a large-grained winter rye surpassed the yield of regionalized varieties (Kharkovskaia 194 and Lisitsinskaia) by 7 - 8 c per 1 ha.

During an unfavorable year, 1954, the yield of large-grained winter rye on an area of 20 ha comprised 16.75, while the variety Kharkovskaia 194, which was grown under the same conditions, gave only 11.4 c per ha. At that, the absolute weight of the large-grained rye equalled 33.3 g, and of the variety Kharkovskaia 194-24.4 g. In the fall of 1954 the Kolkhoz planted 70 ha to the large-grained rye and passed about 100 c of seeds to other Kolkhozes in the region for propagation.

The long-grained rye received a positive evaluation also in Romanovskii raion of Balashovskaia oblast', and in Vol'ski raion of Saratovskaia oblast' (model farm of the Vol'sky Agricultural Technical school). Having received, in 1952, only 8 Kg of seeds of the large-grained rye, the Kolkhoz in the name of Chapaev, of Romanovskii raion, Balashovskaia oblast' propagated them very quickly, and by 1954 they had planted 8 ha with this variety.

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In the model farm of the Saratovskaia Agricultural School, where the presidents of kolkhozes are being trained (in suburbs of Saratov), in 1954 on an area of 1.4 ha, 12 c of seeds of large-grained rye was obtained, whereas the yield of Volzhanka on an area of 2.25 ha was 10.7 c per ha.

The agriculturist of kolkhoz "Nash polius" of Chapaevskii raion, Saratovskaia oblast', Comrad A. Iavrikov, studying the large-grained rye, in 1954, on an area of 0.1 ha, made a conclusion, that in all economically valuable indicators, the large-grained rye is better than Volzhanka and can take its place in production.

The head of a selection group for winter grains of the Kemerovskaia State Selection Station, Comrad Ia. M. Bezel' highly priced the large-grained Saratovskaia rye for its large, full spike of excellent form with large grain. According to his data, this variety suffered very much during 1952/53 winter period, although in other varieties of rye (Omka, Viatka) only 10-28% of plants survived. The large-grained rye on this State Selection Station serves as the best initial material for selection.

In testing the large-grained rye on variety test plots of Saratovskaia oblast', contradicting data were obtained, because the planting was done strictly according to weight norms, without taking into account the size of the seed. In this case the large-grained rye, with an absolute weight of grain of 30-35 g, was planted much more thinly, than other varieties.

That is why it gave lower yields than Volzhanka (table 4).

From table 4 it is seen that, although 140-194 fewer sprouting grains were planted per square meter, it, nevertheless, reduced the yield insignificantly, at the same time surpassing Volzhanka in the large size of the grain, and in the high number of grains per spike.

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Similar data were obtained also on other variety test plots of the oblast'. There were no essential differences among the varieties in their winter hardiness. (Begin p. 86)

Table 4.

Variety	Amount of germinated seeds planted per 1 sq. m.	Productive bushes-iness	Amount of grains in the spike (g)	Weight of 1000 grains (g)	Yield of grain (c/ha)
		Ekaterininski variety test plot			
Volzhanka	619	2.9	0.6	18.6	26.7
Large-grained	426	3.6	0.7	23.1	28.4
		Privolzhskii variety test plot			
Volzhanka	440	4.7	0.8	15.5	17.7
Large-grained	301	5,8	014	17.8	16.0

Note: Data given is for 1954.

Preliminary studies of new populations of large-grained rye on the fields of the Institute have shown their definite prospective value.

The methodical work of formation of each new population of rye is accomplished by us in the following manner. The most economically valuable progenies from the selection nursery are first tested on variety test plots in a separate planting. The best of them are then put together, but only with those coming from the same initial material, and all of them are then again tested. Finally, those progenies which have the same kind of economic indicators but are genetically different are joined into one variety. In a case where small-grained representatives of rye also took part in variety tests, then the formation of

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a new variety of the large-grained rye is conducted from similar materials in the selection nursery.

One should note, that formations of variety-populations of rye are conducted in different ways. Sometimes they are very simplified, and occasionally they are made more complicated. It is not advised, for instance, to unite into a variety any kind of hybrid material, without preliminary test propagation, and examination of the progeny. It is necessary to know when and what can be joined. And this calls for a specific order in the work.

Besides this, it is not necessary to especially adhere to the popular schemes of selection. Excessive breaking up of the rye hybrid material and their fractional studies in the course of several years does not always lead to necessary results.

A method of complex hybrid populations is now the basis for successful work in the selection of rye. Thus it was not by chance that such new varieties of rye as Partizanskaia, Sibniiskhoz 1, and others came into being. A.M. Bogomolov is now working in this direction with great success on Beniakovskaia Experiment Station; Ia.M. Svirskii on Byelorussian State Selection Station; V.P. Kuz'min on Shortandinskaia Experiment Station (A-kmolinskaia oblast'), and others. Our problem is how to improve the existing large-grained rye and to organize its wide production study.

Of great importance in seed raising of winter rye is the improvement of the widely regionalized variety of winter rye, Volzhanka, by means (Begin p. 87) of mass selection. In order to obtain initial material for this variety which is variegated in its heredity, we conducted a selection of the best spikes on high-yielding seed raising plantings. With a following repollination such a selection

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is increasing considerably the vitality of the variety, and, consequently, its yielding capacity. After this, all the selected rye spikes were united and threshed together. The obtained crop of grain was then brought to proper conditions and planted in the nursery, in a so-called seed plot for mass selection, whose area is 0.5-0.6 ha. In order to plant this area, quite thinly one needs 16-20 thousand spikes, reckoning that each thousand spikes produces 1 kg of seeds. In this case, at the expense of intensified tillering, an almost normal stand of grass and a high yield are obtained. High agrotechnics are used on this plot, and an additional artificial pollination is practised.

Seeds, which are obtained from the seed plot for mass selection, are first used for a preliminary propagation; only superelites and elites are used for the next planting. Method and norms for planting, in this stage of work, are the usual ones. The large size and the heavy weight of seeds get the main attention in the initial stages of seed raising.

An opinion that the use of screens for selection of large size grains and the utilization of wind produce emptiness in spikes is not true, as was ascertained by our experiments. From one party of seeds the selected large and small seeds of the Volshanka variety were planted in a basic competitive variety test of rye. The results obtained are shown in table 5.

Table 5.

Seeds	Weight of 1000 planted seeds (in g)	Yield of seeds (g/ha)	Weight of 1000 obtained seeds (in g)	% of emptiness in rye spikes
Small.....	17.1	24.5	15.2	22.0
Large.....	27.4	27.5	16.5	21.1

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Results of the experiment show, that when large-grained seeds of rye are planted, the emptiness of spikes is somewhat lowered, and the yield of grain comprises 5.2 c per ha.

Consequently, selection of large and heavy grains of rye helps in the increase of the yielding capacity.

In order to study the effectiveness of mass selection in seed raising of rye compared to other forms of selection, we conducted special experiments. For this purpose on the Volshanka variety plantings we conducted a twofold mass selection for grains, and also for spikes; after this we usually planted the seeds in the selection nursery and in the seed raising nursery. The yield obtained from this was studied in the basic variety tests of rye (table 6).

Table 6.

Kinds of seeds which were planted	Yield of grain (c/ha) in 1949
Twofold mass selection for grains.....	18.8
Twofold mass selection for spikes.....	19.2
Selection nursery and seed raising nursery	18.7

(Begin p. 88)

From data of table 6 it is seen that Volshanka, which was planted in seeds from mass selection for spikes, gave better yields than with any other methods of selection. Evidently this result is not accidental, because when selection is done for grain alone, the amount of grains in a spike, which is the essential indicator of the yielding capacity, is not taken into consideration.

Besides this, in a scheme of seed growing: in the selection nursery and in the seed raising nursery from 2-2.5 thousand of initial progenies comprise a population, whereas with the mass selection for spikes there were 6-8 times more

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of such progenies in the population. It is possible that this influenced the yielding capacity of the variety also.

One should take into account also, that propagation of rye elites according to the scheme of selection nursery, seed raising nursery, and others is always connected with great difficulties. This is due to the large scale of work in the nurseries where often the started lines run into several thousand deeds making it practically impossible for the selectioners to conduct their detailed study and selection. As a result of this, the quality of seeds which are put out is lowered. Sometimes it may be quite to the contrary: the seed raising work is simplified, by curtailing the amount of the initial material in nurseries, which should not be done, as it might lead to a deterioration of the variety.

A method of mass selection with a number of initial spikes (not less than 10-15 thousand especially if they were taken from various plots and in different years of yields) is helping to gradually improve the variety. Technically this method of selection is quite simple and conforms to the biological peculiarities of this crop.

In order to check the quality of the Volzhanka seeds, they are periodically studied in competitive variety tests with seeds of the same rye variety, but from older generations, taken from various regions of Saratovskaia oblast'. Results of a competitive variety test of rye, Volzhanka variety for 1952, are given in table 7.

Volzhanka of Balashovskii and Dergachevskii raions gave lower yields than the one from the Institute. But Volzhanka from the Turkovskii raion surpassed that of the Institute in yielding capacity. It is possible that in this case this was a result of conditions of Volzhanka's training for several preceding years, because in Turkovskii raion the climatic conditions are far more favor-

(cont. after table 7)

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Table 7.

Origin of seeds	Yield of seeds (c/ha)
Elite seed raising farm of the Institute	27.7
Balandinskii raion.....	24.3
Turkovskii raion.....	28.2
Dergachevskii raion.....	26.0

Note: (x)

able for the growing of all agricultural crops.

In 1953 Volzhanka from six raions gave a lower yield than that of the Institute.

In 1954 this experiment was repeated; for this tests seeds used were: of Volzhanka, of elder reproductions from Balashovskii and Dergachevskii raions, repollinated in variety tests and of the Institute's repollinated Volzhanka of mass selection.

This method of experimenting seemed to be justified, as in this case in the Institute we had one full year of equalized sowing. Repollination here concerned all varieties in equal measure, thus they could be fully compared to each other. Data of the competitive variety tests is given in table 8. (Begin p. 89)

Table 8.

Origin of seeds of the variety	Yield of seeds (c/ha)	Absolute weight of seeds (g)	Yield of quality seeds (%)	Amount of seeds in spikes	Emptiness of rye spikes (%)
Institute	17.4	15.2	76.2	53	15.3
Balashovskaia.....	17.3	15.2	70.0	50	17.9
Dergachevskaia	16.8	13.5	69.5	49	19.5

(x) During ripening of the grain the weather was dry and hot.

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From table 8 it is seen that the Institute's Volzhskaia occupies first place not only in yielding capacity, but in many other economic indicators. The fullness of the spike (or the amount of grains in one spike) is higher not only because there is less emptiness, but also because of the longer length of the spike.

The absolute weight of rye seeds is low on account of the climate (heat and absolute lack of rain during ripening of grain).

Thus the method of mass selection of best plants or spikes in seed raising of rye corresponds fully to Michurin's agrobiological science in the preservation and further improvement of the existing, high-yielding varieties of winter rye.

VM/BM
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Translation A-718
(In full)
By: V. Makarenko

Zhdanov, L.A.

Osnovnye rezul'taty rabot po selektsii maslichnykh kul'tur.

[Basic results of work on selection of oil-bearing plants.]

Agrobiologia, no. 4, pp. 59-71, 1955. 20 Ag622

(In Russian)

A 718

Michurin's teachings have a powerful, reforming influence on the development of all the branches of the science of biology. The results of selection in various agricultural crops, including the oil-bearing, show especially clear the mighty strength of these teachings.

A many-sided agrobiological study of oil-bearing crops is conducted by the All-Union Scientific Research Institute for Oil-bearing and Essential-oil-bearing Plants (VNIIMEMK), as well as the Donskaia and Voronezhskaia stations, which belong to its network; also the Institute of Agriculture of South-East USSR, the laboratories for oil-bearing plants of the All-Union Institute of Plant Cultivation (VIR), and some other institutes and experiment-selection stations.

The main purpose of the selection process is to obtain plants with an unstable heredity, their training, and a directed selection.

In order to obtain an oil-bearing plant with an unstable heredity, the Soviet selectioners, following the instructions of Michurin's teachings, influence the plant's body in the process of its development by conditions of its life; they crossbreed forms and varieties which are different in their origin and biological properties; they also use vegetative hybridization. When utilizing the hybrid method, they also try to create agrotechnical conditions, which will help to

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change the properties of the plants in increasing their yielding and their oil-bearing capacities. Very informative are the works of the Institute of Agriculture of South-East USSR in which they studied the influence of training conditions on the formation of properties in a hybrid progeny of a sunflower plant (K.V. Marezow, 1960). It was established by research, that if hybrids are trained on various backgrounds, then the plants form different properties in the second-third generations (table 1).

Table 1.

Influence of repeated cultivation on the formation of hybrid progeny of sunflower (data of the Institute of Agriculture of South-East USSR)

Indicator	Stepniak X Jubilein 61			
	One-year cultivation on solonets	Three year cultivation on:		
		solonets soil	on sandy loam	irrigated land
Height of plants (in cm).....	88.0	111.0	108.0	189.0
Yield of seeds from one plant (g)	19.0	53.0	14.0	58.0
Absolute weight of seeds 1000 (g)	52.0	55.0	40.0	56.0
% of oil in seeds.....	35.9	38.6	39.7	27.5

(Begin p. 60)

Research which was carried out, has shown that the differences, which are observed in the same hybrids grown on different grounds, have a tendency to become fixed; this shows most clearly in relation to the oil content of the seeds and to resistance to the affection by broomrape. In addition to this, it was established, that under conditions of Saratovskaia oblast' the most high oil

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containing progeny of sunflower was formed on sandy loams.

Results of hybridization, as it was pointed out by I.V. Michurin, depend both on the conditions of life during the period of pollination and on the formation of seeds in parent forms. Let us cite an instance from the work of Donskaia Experiment-Selection Station for Oil-bearing Crops on a comparative study of hybrid seeds of sunflowers, which were obtained in kolkhozes "imeni Kominterna" in Samarovski raion, and "Molot" in Miasnikovskii raion, Rostov oblast', from cross-pollination (in 1949) of the variety 8281 by the pollen of varieties 6540 VNIIMK and 1646 VNIIMK. The moisture content of the soil and the weather conditions in these kolkhozes varied very much during the period of growth and development of sunflowers during the year when hybrid seeds were obtained. In the kolkhoz "imeni Kominterna" the growth and development of the sunflowers proceeded under very dry conditions; on account of the lack of soil moisture the plants were very oppressed; in the kolkhoz "Molot", where there was plenty of rain on the fields, before and after blooming of the sunflowers, they attained a large size and gave a high yield.

Comparative experimenting in 1950 on Donskaia Experiment-Selection Station with hybrid seeds, which were formed during the previous year under different conditions, has shown, that the seeds differ very noticeably in their yielding properties. Seeds from the kolkhoz "imeny Kominterna" gave a yield of 18.05 c per 1 ha, and from the kolkhoz "Molot" --19.6 c per ha.

Donskaia Experiment-Selection Station for Oil-bearing Plants, as well as other experiment institutions have established, that with a certain selection of parental pairs, the sunflower hybrids receive many properties which are inherent to the mother plants, and, in particular, resistance to broomrape.

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It is very important as a selection practice to define the character of variability of sunflower hybrids in the oil content and the quality of seed hulls. In a series of experiments with cross-breeding of sunflower varieties, which differ in the content of oil in the seed kernels, it was seen that in this respect the hybrids approach their high-oil-content parent, and in some cases even surpass it (table 2).

Table 2.

Contents of oil in kernels of seeds of the parent forms and of the first hybrid progeny. (data of the All-Union Institute for Oil-bearing and of Essential Oil-bearing Plants.)

Parental forms		% of oil in an absolutely dry kernel		
Maternal	Paternal	Maternal form	Paternal form	First hybrid progeny
Kruglik 1975	Karlik Stepnoi Stantsii	58.5	60.9	59.4
Karlik Stepnoi Stantsii	Kruglik 1975	60.9	58.5	59.6
Fuksinka Voronezhskaia 3	Omskii skorospelyi	56.7	48.6	57.6
Omskii skorospelyi	Fuksinka Voronezhskaia 3	48.6	56.7	58.2

According to numerous data, 1st generation hybrids from the cross-breeding of thin-hulled varieties of sunflower with those of coarse-hulled quality seed hulls lean towards the coarse-hulled parent. (Begin p. 61)

Donskaia Experiment-Selection Station for Oil-bearing Plants proved, furthermore, the expediency for rejecting the coarse-hulled forms of sunflowers in the first hybrid generation.

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The Soviet selectioners discovered some facts, which are very important for selection, about the character of variability of the content of oil in the hybrid generation of other oil-bearing plants. Thus, in Voronezh Experiment Station the first hybrid generation of oil-bearing flax as also of sunflower, deviates in its content of oil toward that of the high-oil-content parent.

The wide experimental material testifies that the oil content in the seeds changes strongly depending on the condition of growth and on methods of agro-technics.

Soviet selectioners have done a lot in the study of conditions which are guiding hereditary variability in the direction of increase in the oil-content of seeds. For example, the Voronezh Experiment Station for Oil-bearing Plants found out, that the increase in oil content and in yield of the hybrid progeny is achieved by training the plants on a more moist and fertilized ground and planting them further apart from each other.

As a result of directed training in conjunction with intervarietal pollination, the station has succeeded, for the last 6 years, in increasing the oil content of flax seeds of the variety Stepnoi by 3.8% (from 41.8 to 45.3%), and of flax, variety Kagal'nitskii 1551--by 2.1% (M.D. Rafonov, 1952).

A certain correlation between the oil content in seeds of some oil-bearing crops and other properties of plants have also been established. Thus, forms of a cultivated sunflower with dark and black color of seeds, have, in most cases, a higher oil content than the forms with light gray color of seeds.

In order to obtain an oil-bearing plant with an unstable heredity and, consequently, one which is more responsive to the form-producing influence of the outer environment, the selection institutions of USSR have begun to utilize remote crossbreeding over so much wider; for instance, cultivated varieties

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of sunflowers with a one-year wild variety of sunflower Ruderalis, as well as with perennial varieties of this plant (H. tuberosus, H. rigidus, H. tomentosus, and others); Lallemantia iberica with Lallemantia "pel'tata"; dark blue mustard with Camelina. In such a way were obtained, for instance, sunflower hybrids, which are resistant to rust and broomrape; also a taller variety of Lallemantia, which can be harvested mechanically.

The role of conditions of the outer environment in the formation of peculiarities in plant bodies is especially clearly revealed in the works on vegetative hybridization.

Numerous data speak of the fact that in sunflowers, as in other crops under the influence of one of the grafted components, arises a hereditary variability of the other component in many of important characteristics and attributes. It is established, that as a result of vegetative hybridization of sunflower varieties, which differ in resistance to broomrape, correlations between the plant-host and the parasite change sharply in the seed generations. It has been proved also, that with the aid of vegetative hybridization it is possible to regulate the duration of vegetative periods of sunflowers.

Donskaia Experiment-Selection Station for Oil-bearing Crops together with a branch of genetics and selection of the Biological Institute of the Rostov State University have conducted experiments, in which the grafting components were, on one hand, more early-ripening and shorter in height varieties of sunflower of Donskoi selection--6432, Stepniak and L-469, and on the other hand, more late-ripening and taller varieties of Krasnodarski selection--6540 VNIIMK and 1646 VNIIMK. In these tests they conducted the straight and the counter-graftings, whereupon in all (Begin p. 62) cases the scion was trained at the expense of the assimilating apparatus and the root system of the stock. (Fig. 1)

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Title of Fig. 1--Vegetative hybrid of a sunflower; scion of one variety, was trained at the expense of the assimilating apparatus and of the root system of the stock, which was of another variety.

A change in the length of the vegetative period of the sunflower, under the influence of the stock, is quite clearly noticed not only in the first-third seed generations of vegetative hybrids, but also in the fourth (table 5).

Table 5.

Influence of vegetative hybridization of sunflower on the change of length of vegetative period and of the height of plants in the fourth seed generation. (data of Donskaia Experiment-Selection Station for Oil-bearing Plants and of the Biological Institute of Rostov State University, 1950.)

The kind of seeds that were sown	Components		Length of the vegetative period (in days)	Height of plants (cm)
	Scion	Stock		
Original, variety 6540 VNIIMK, control.....	-	-	107	131
Vegetative hybrid.....	6540 VNIIMK	6452	100	107
Same.....	6452	6540 VNIIMK	105	112
Original, variety 6452, control.....	-	-	96	109

From the data of the table it follows, that under the action of a more early-ripening and a shorter-in-height stock the heredity of a comparatively late-ripening and tall variety of sunflower, which served as a scion, has changed: the length of the vegetative period diminished and the height of the stock decreased. Under the influence of plastic substances of the more late-ripening

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and taller stock these indicators moved in the scion in direction of an increase.

Results of research (Shmuk, Evtushenko, Ilin, Rubin, Sisakian, Glushchenko, Batikian and others) have shown, that in tobacco, peas, tomato, sugar beets and in some other plants under the influence of grafting, the flow of physiological processes is altered; the fermentation system undergoes deep changes. Concerning the sunflower, the physiological laboratory of Donskaia Experiment-Selection Station for Oil-bearing Crops has found out, that in the intergrowing components the intensity of respiration changes, as also does the ability of the leaves to retain water. According to the observations of the Siberian Scientific-Research Grain Institute in the first and second seed generations of vegetative hybrids of the sunflower (scion-Pioner Sibiri, stock-high-oil-content (Begin p. 68) varieties 4009 VNIIMK and 4418 VNIIMK) the oil content of seeds increased.

Increase in oil content in seeds of vegetative hybrids was also seen in many cases by the Donskaia Experiment-Selection Station for Oil-bearing Crops (table 4).

Table 4.

Productiveness of vegetative hybrids of sunflower

(data of experiments on the Donskaia Experiment-Selection Station for Oil-bearing Crops, 1953.)

No. of variety of scion and of the vegetative hybrid.	Yield of seeds (in c/ha)	Yield of oil		% of oil in absolutely dry seeds	Height of plants (cm)
		c/ha	%		
1646 VNIIMK, original seeds, control	17.89	6.20	100	37.75	154.6
Vegetative hybrid no. 11, 4th seed generation (scion 1646 VNIIMK).....	18.84	6.61	106.6	38.17	162.7
L-469, original seeds, control.....	18.09	6.19	100	36.23	144.3
Vegetative hybrid no. 1, 4th seed generation (scion--L-469).....	20.08	7.51	118.1	38.55	164.6
595, original seeds, control.....	18.50	6.98	100	39.95	156.2
Vegetative hybrid no. 40, 3rd seed generation(scion-595).....	19.92	7.42	106.8	39.45	160.6

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Kharkov selection station, on the basis of preliminary data, also comes to the conclusion that the high oil content scions increase the oil content in seeds of the scion. Besides this, according to the observations of this station, the quality of hulls and the color of seeds can vary under the influence of grafts.

Thus, data which was obtained testifies quite convincingly, that all the characteristics and signs of the sunflower can undergo hereditary changes, as a result of vegetative hybridization. At the same time vegetative, as well as sex hybridization is followed by an increase in the vitality of plants. This is confirmed by results of a comparative test of the third-fourth seed generations of vegetative hybrids and of corresponding original varieties.

Data of table 4 once again confirm the important meaning of vegetative hybridization when breeding new varieties of oil-bearing crops. The method of grafting overcomes the cross-incompatibility of remote forms and eliminates the sterility of interspecies hybrids. It is known, for instance, that by cross-breeding a sunflower with Jerusalem artichoke (H. tuberosus) it is possible to obtain hybrids, but they are sterile. Quite different results were obtained by the All-Union Scientific-Research Institute of Oil-bearing and Essential Oil-bearing Crops in those cases when hybridization was preceded by a preliminary vegetative approach of these species. The interspecies hybrids were quite fertile, whereupon in the fourth generation an intensified form-producing process and a development of forms was observed; forms which were not only close in morpho-

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logical signs to the cultivated varieties of sunflower, but at the same time also having a resistance to rust (A. Ia. Panchenko, 1954).

Principles of Michurin's biology about the vitality of the plant body and of selectivity during fertilization are of exceptional value. Methods and measures of improvement of breeding qualities of plants--additional artificial pollination, intravariety, and, especially, the free, intervariety pollinations, based on Michurin's principles produce a great effect in the selection-seed growing work with oil-bearing plants. Successes of recent years in obtaining new and in the improvement of previously bred varieties of sunflowers are conditioned mainly by utilization of free intervarietal pollination which has a great advantage over other methods where selectivity is limited during fertilization. Thus, according to the data of the All-Union Scientific-Research Institute of Oil-bearing and Essential Oil-bearing Plants (Pustovoit, 1940), the hybrids of the sunflower of the first generation from the free intervarietal pollinations surpassed in their yield the original varieties by 9-14%. Results of this experiment fully correspond to those results which were obtained by some of the other experiment-selection institutes in different regions of the country.

(Begin p. 64)

Numerous tests with the intervariety free pollination of oil-bearing crops have ascertained quite clearly, that this method increases the vitality of the plants and improves their breeding qualities. According to data of experiments conducted by the Chair of Genetics and of Selection of Moscow State University, in the name of M.V. Lomonosov, the pollination of the sunflower by a mixture of pollen, and in a large quantity, increases the tempo of the development of the embryo, increases the percent of fertilized embryo sacs and of germinated seeds (E.I. Ustinova and T.T. Nesterova, 1951); in field experiments of Donskaia Experiment-Selection Station for Oil-bearing Crops an increase in diversity of

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pollen and of its amount increased the yielding capacity of sunflower hybrids by 7-14%; according to the observations of Voronezh Experimental Station, in case of an increase in the amount of pollen, the effectiveness of pollination of the oil-bearing flax rises 3.5-5 times (M.D. Safonov, 1952). Along with this, it was found out under what conditions the oil-content of seeds rises in intervariety hybrids of the sunflowers.

During a combined breeding of varieties, with close indices in the quality of the hulls and in the content of oil in the seed kernels, these properties in the intervariety hybrids improve in many cases. This principle is confirmed by the following example (table 5).

Table 5.

Oil-bearing capacity and productivity of plants of the first generation of hybrids from a free cross-pollination of sunflower varieties, which are close in oil-bearing capacity and in the quality of hulls.

(data of VNIIMK, 1949, V.S. Pustovoit, 1950.)

Kind of seeds sown	No. of variety, of hybrid	% of hulls	% of oil in absolutely dry		Yield of seeds (c/ha)	Yield of oil (c/ha)
			Kernel	Seed		
Original (elite)	1646 VNIIMK, improved.....	32.2	59.8	42.4	26.7	10.20
Hybrids	1646 VNIIMK X X 6540 VNIIMK	29.4	60.7	44.6	26.9	11.61
"	6540 VNIIMK X X 1646 VNIIMK	29.8	60.6	44.4	26.9	11.54
Original (elite)	6540 VNIIMK.....	30.5	61.0	44.3	26.6	10.60

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Intervarietal, free pollination influences, especially positively, the quality of hulls and the oil content of the seeds of the maternal variety of sunflower, if the pollinators were the high-productive varieties with thin hulls and with an increased oil content in seeds. Pollination of the thin-hulled and of high-oil-content varieties by coarse-hulled and of low-oil-content varieties leads to a decrease of oil content of seeds of the maternal variety, mainly through a larger content of hulls. At the same time in the coarse-hulled, of low-oil-content, varieties grown in the surroundings of thin-hulled, and of high-oil-content, the content of hulls decreases, and the oil content of seeds (Begin p. 65) increases. Selection institutes have also found out, that in generations obtained by pollination of broomrape-resistant varieties of sunflower with non-resistant ones, the resistance to broomrape falls sharply. On the other hand, from pollination of varieties which are affected by broomrape by those which are resistant to broomrape, hybrids are obtained which are resistant to this parasite.

All the above testifies to the dependence of the results of free intervarietal pollination on the peculiarities of varieties which were taken for repollination, including the maternal variety. This condition can be confirmed by such an example (table 6).

Table 6.

Effectiveness of the intervarietal free pollination of sunflower, depending on the biological peculiarities of the maternal variety. (data of Donskaia Experiment-Selection Station for Oil-bearing Crops, 1947.)

Variety taken as maternal	Seeds that were tested	Yield of seeds		Yield of oil	
		c/ha	%	c/ha	%
Stepniak (K-1465)	Original, crop of 1946...	20.65	100	7.12	100
	From intervarietal pollination, crop of 1946.....	22.65	109.7	7.96	111.0
L-469	Original, crop of 1946...	19.08	100	6.94	100
	From intervarietal pollination, crop of 1946.....	19.74	103.4	7.07	101.9

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Thus, in order to receive a selection effect from intervarietal free pollination, it is necessary to correctly select the varieties, and, besides this, create appropriate conditions for training the plants; also to conduct a purposeful selection.

The efficacy of Michurin's doctrine, on the selectivity of fertilization and on the means to increase the vitality of the plant body, is confirmed by wide selection practice. Precisely on this basis it was possible, in a short time, to considerably improve the previously bred varieties of sunflower and create new ones, which are distinguished by their high yielding capacity, by thin hulls, high oil content, and other valuable peculiarities and properties. Thus, the highly productive variety 1646 VNIIMK, which was bred by a method of repeated individual selection, and is widely spread, at present time, in many regions of USSR, was improved by means of directed intervarietal free pollination. Results of experiments have shown a considerable superiority of hybrid seeds of this variety compared to the usual.

Donskaia Experiment-Selection Station for Oil-bearing Crops increases continuously, on the same basis, the process of seed growing work, the oil content of varieties previously bred by it and regionalized varieties of sunflowers Zhdanovskii 6281 and Stepniak, which is seen from data of table 7.

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Table 7

Increase in oil content of sunflower varieties 8281 and Stepniak as a result of improvement by Donskaia Experiment-Selection Station for Oil-bearing Plants. (data of competitive test on the experimental base of VNIIMKM in Krasnodar)

Variety	% of oil in absolutely dry seeds					
	1944	1946	1948	1950	1952	1953
8281	35.62	36.87	37.27	38.49	39.04	41.0
Stepniak	36.37	38.95	38.11	40.34	41.28	41.55

The oil content of the variety Saratovskii 169, which is spread in many eastern regions of the country, was considerably increased by the Institute of Agriculture of South-East USSR. (Begin p. 66)

Title of fig. 2 Sunflower head of Donskoi 695 variety.

Side by side with the improvement of the previously obtained varieties, in recent years, by means of directed intervariety free pollination and of selection, new varieties were bred which are high-productive and of high oil content. In pre-revolution times the oil content of cultivated sunflower varieties did not exceed 32-33%, and the factory output of oil from seeds--19-24%. The first selection varieties of sunflower: Khar'kovskaia zelenka 76, Voronezhskaia fuksinka 3, Saratovskii 169, varieties Krugliak and others did not differ much in their oil content from local varieties, which served as initial material for selection. In 1927, selection station "Kruglik" bred a variety Kruglik A/41 with an oil content of 36%. This was the beginning for the selection of sunflowers on high oil content in the seeds.

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Leaning upon Michurin's doctrine, the selection institutes of USSR have bred such high oil content varieties, that former ideas about oil content of sunflowers were completely changed. Varieties 1646 VNIIMK, 6540 VNIIMK, Voroneshskaia Chernianka 11, Stepniak (K-1465), Saratovskii 10 and many others accumulate, with proper conditions of growth, an estimated 40-44% of oil in absolutely dry seeds. In the collection of oil from 1 ha they surpass old varieties by 10-20% and even more. The cited new varieties occupy the basic areas of sunflower sowings in the Caucasus, in Ukrainian SSR, in Moldavian SSR, in the land along the Volga, and in many regions of the central zone of RSFSR.

Owing to the increase in oil content of the previously bred varieties, to the creation of new varieties with high oil content and their introduction into production, the yield of oil from one unit of planting and its output at reprocessing of seeds on factories have considerably increased. Thus, on many factories of Glavvneshtorgmasla (Main Administration for Vegetable Oils) the output of oil from sunflower seeds in 1953 equalled 52-53%, whereas during the prewar period it consisted of only 28% (V.S. Pustovoit, 1954).

Soviet selectioners produced new varieties of sunflowers: 8951 VNIIMK, Armavirskii 3497, Zelenka Veidelevskaia 368, in which oil content reaches up to 46-47%, under favorable conditions. Beginning with 1953 these varieties were regionalized and at present are being introduced into production.

Besides this, new, promising varieties of sunflowers were obtained--8885 VNIIMK, Armavirskii 9343, 8932 VNIIMK, Donskoi 695 (fig. 2), Donskoi 2543 and others. They are characterized by early-ripeness, high yielding capacity and oil content, with a high resistance to broomrape, and are adapted to mechanized harvesting. Some of them, for instance 8885 VNIIMK, are already

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being regionalized, others have been included in Government variety tests, or are going through Station tests and evaluation under conditions of production on farms. (Begin p. 67)

Title of fig. 3.. Flower heads and roots of sunflower plants, cultivated on ground, choked up with broomrape B; 1,2--varieties resistant to broomrape, 3--a variety which is not resistant to broomrape.

Title of fig. 4.. Mass blooming of sunflower variety 8281, which is resistant to broomrape.

Side by side with this, the selection institutes have evolved hybrid families and plants of sunflowers, the oil content of whose seeds reaches up to 50-56%. This testifies to the fact that there are possibilities of developing still more perfect varieties.

The most important line to take in the work with sunflowers appears to be the selection for the ability to resist broomrape, which can cause big losses to sunflower plantings.

Development of such varieties as Saratovskii 169, Kruglik A/41, Kharkovski zelenka 76, which are resistant to broomrape has made it possible to increase the yield of this crop in many regions. But later it was found out, that in many of the basic regions of sunflower cultivation, all the cited selection varieties, as well as the local ones, were affected by broomrape.

As the researches, conducted by Donskaia Station VNIIMKK and by other experiment institutes have shown, the cause of this consists in the fact that there are more virulent forms of the parasite; they were given the name of broomrapeS. It was necessary to develop sunflower varieties which could resist the injurious action of this more aggressive form of parasite (fig. 5). Not-

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withstanding the difficulty of the problem, (Begin p. 68) Soviet selectioners have successfully solved it. The first broomrape-resistant varieties--6281, 6452, and others were developed by Donskaia Experiment-Selection Station (fig. 4).

Further on, were obtained new broomrape-resistant varieties with a high oil content of the seeds--1646 VNIIMK, 6540 VNIIMK, 8931 VNIIMK, Stepniak (Donskaia Station), 5497 (Armavirski base) Zelenka 568 (Veidelevski Experiment Field) and some others.

Broomrape-resistant varieties are now occupying the basic areas of sunflower plantings in USSR. In regions of broomrape B spreading, they are much more highly yielding than the varieties which are not resistant to broomrape. Thus, in 1947, on the Donskaia Experiment-Selection Station for Oil-bearing Crops the yield of seeds of the broomrape-resistant variety 6281 constituted 22.6 c per ha, and the 4036 VNIIMK, which is not broomrape-resistant yielded only 2.7 c. In 1949, under conditions of Krasnodar, the broomrape-resistant 6540 VNIIMK gave 31.8 c of seeds per ha, but the non-broomrape-resistant variety Kruglik A/41 -- 14.3 c.

Soviet selectioners have created early-ripening sunflower varieties for more northern and eastern regions. The high-yielding variety Shortadinskii 41, which has a heightened oil content and was selected by Shortadinski Agricultural Experiment Station, ripens in Siberia, Kazakhstan and on Ural 7-10 days earlier than Saratovskii 169 and Pioner Sibiri.

VNIIMKMK and the Donskaia Experiment-Selection Station for Oil-bearing Crops are conducting the work, which is directed toward obtaining varieties of sunflowers that are resistant to rust, which in many regions causes considerable losses to the yield of this crop.

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The interspecies, rust-resistant hybrids 14905 and 14902, which were bred by VNIIMKMK, have surpassed, according to data of experiments in Krasnodar, in 1952-1955, the high oil content variety 8931 VNIIMK in the yield of oil by 198-518 Kg per 1 ha (V.S. Pustovoit, 1954).

Hybrids 4198, 4162 and others, which were obtained on Donskaia Experiment-Selection Station from crossbreeding of cultivated varieties of sunflower with a wildly growing one-year form of Ruderalis, were high-yielding, and at the same time moth-resistant and resistant to rust and broomrape. During the station's variety tests in 1954 they surpassed the high-oil-content variety 6540 VNIIMK in the yield of seeds by 2.3-3.3 c per 1 ha, and in the yield of oil by 82-127 Kg per 1 ha. But the above hybrids are too late-ripening. It is contemplated to eliminate this deficiency by way of vegetative hybridization, by additional repollination with the best broomrape-resistant varieties and by repeated selections of early-ripening plants.

* * * *

Besides the basic oil-bearing crop-sunflower, in USSR are also cultivated the castor plant, flax, mustard, false flax (Camelina sativa), sesame, peanut, Lallemantia F. et M., Perilla, poppy, safflower and soybean.

Soviet selectioners have created new, high-productive varieties of these plants also.

Voronezh experiment station developed a high-yielding variety of oil-bearing flax Voronezhskii 1308. This variety, which is characterized by good oil content, resistance to drought and by adaptability to mechanical harvesting, has been regionalized since 1943 and became one of the most widespread.

In many oblast' of the country considerable areas are occupied by a high-productive variety of flax 1650, selection of the All-Union Institute of Plant

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Cultivation.

A variety of flax, Sibiriak, which was developed by the Altai Institute of Agriculture and of Animal Industry, has very valuable properties. This variety is regionalized in Siberia, Kazakhstan and Ural. (Begin p. 69)

The following selected varieties of flax are characterized by their high-yielding capacity, their oil content and other positive properties: Krupnosemiannyi 5 (Kubanskaia Station of All-Union Institute of Plant Cultivation), Kirovogradskii 71 (Ukrainian Station for Oil-bearing Plants), Krymskii 250 (Krymskaia Selection Station), Donskoi 166, Bakhmal'skii 1056 (Miliutinskaia Selection Station), and others. They are all regionalized and under production.

In recent years, new promising varieties of oil-bearing flax were developed. In the oil content in their seeds they surpass the previously obtained by 1.5-2% and more. This refers, in particular, to the new varieties of Kirgizskoi Selection Station--Zheltosemiannyi and Frunzenets, which were developed by means of intervarietal crossbreeding for irrigated and non-irrigated lands of Kirghiz.

No less valuable are the results of selection of the castor plant and of peanuts. These crops, which spread in our country only after the great October socialistic revolution, are now successfully cultivated in the Northern Caucasus, in Ukrainian SSR, in republics of Central Asia and in Transcaucasia.

Besides the previously developed and widely spread varieties of castor plants (Kruglik 5, Donskaia 172/1, Tashkentskaia 351), the Soviet selectioners obtained new varieties of the type Sangvinaus, whose bolls do not crack at ripening: 401 VNIIMK, synthetic Sangvineus VNIIMK, 98 of the Kubanski Station of the All-Union Institute of Plant Cultivation; 39/44 of Donskaia Experiment-Selection Station for Oil-bearing Crops, and others. Some of them are already

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regionalized, others are put through Government variety tests. These varieties are characterized by a high oil content; they are high-yielding and resistant to drought. On Donskaia Station the variety Sangvineus 59/44, for a period 1948-1955, on the average, surpassed the regionalized variety 172/1 in the yield of oil by 42 kg per 1 ha; and in the content of oil in the seeds by 2%.

By means of remote hybridization, VNIIMKMK obtained new, promising varieties with non-cracking bolls and with leaves which fall off before harvest time; this makes it possible to use the monophase, combined type of harvesting (fig. 5) (V.E. Borkovskii, 1951).

Quite substantial are the results of peanut selection. Peanut, being a plant from southern and moist countries, ripens very late in more northern regions.

The most important problem of selection for this crop in regions with a moderately warm climate is the development of early-ripening varieties, which nevertheless must be high-yielding and have a high oil content. The All-Union Scientific Research Institute for Oil-bearing and for Essential Oil-bearing plants developed, by means of hybridization of specially selected forms, early-ripening and high-yielding varieties of peanuts from which Stepniak 1657 VNIIMK and Krasnodarskii 1708 are regionalized and which are quite suitable for cultivation in the Northern Caucasus and in the south of Ukrainian SSR. The Institute obtained new hybrid varieties of peamnts--Adyg, and others, which surpass in yielding capacity and size of beans those which were developed earlier (D.P. Umen, 1952). Variety Perzuvan 46/2, from selection of Azerbaijan Experiment Station for Oil-bearing Crops is also high-productive. This is one of the best varieties for irrigated lands of Transcaucasia and Central Asia. Varieties of peanuts Tashkentskii 62 and large-fruit Tashkentskii 112 which were selected

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by the All-Union Institute of Plant Cultivation, are also high-yielding on irrigated lands in regions of Central Asian republics.

Soviet selectioners also created high-productive varieties of other oil-bearing crops. (Begin p. 70)

Title of fig. 5. Castor plant, variety 165 VNIIMK.

Title of fig. 6. Plant of Lallemantia; left-variety Vysokoroslaia 26, right-Donskaia 24.

Varieties of bluish mustard, selection of Stalingrad State Selection Station, --Neosypaiushchaiasia 2 and Stalingradskaia 189/191, as well as a variety of white mustard--162 VNIIMK are all widely spread.

Valuable varieties of sesame were also developed. Regionalized from them are Tashkentskaia 122 (selection of Centralasian Station of the All-Union Institute of Plant Cultivation), Kubanets 56 (All-Union Institute for Oil-bearing and Essential Oil-bearing Crops), Beloseminnii 7-č, and Serakskii 470-č (Turkmenskaia Selection Station), Odesskii 559 (All-Union Selection-Genetical Institute), and some others. By means of crossbreeding and selection, forms were obtained which are more resistant to seed shedding and whose leaves fall off during the period of ripening. Forms of sesame with six-nidi bolls, which are characterized by a heightened yield and other positive properties, were also developed. At the same time it was established, that as a result of inter-varietal crossbreeding with free blooming, the yield of sesame oil increases 14-16%. All this testifies that it is quite possible to develop still more valuable varieties of sesame.

Selection institutions have created new varieties of Lallemantia. Besides the previously developed varieties Donskaia 2 and Donskaia 24, the Donskaia Station developed a hybrid variety of Lallemantia-Vysokoroslaia 26 with a small

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stalk, which permits mechanized harvesting (fig. 6). Two other new varieties of Lallemantia, Donskaia 74 and Donskaia 152, selections of the same station, and which are now under Government variety tests, are characterized by resistance to diseases of wilt caused by macrosporiosis and bacteriosis. In certain years these diseases are (Begin p. 71) widely spread. That is why it is important to develop varieties of Lallemantia which will be resistant to these diseases. From among new varieties, the Korak, which was developed by the Botanical Institute of the Academy of Science of the Armenian SSR by way of selection from the wildly growing forms of Lallemantia in dry regions of Armenia, merits attention.

A series of valuable false flax varieties was also developed, as well as of the winter and spring rape, safflower, poppy, Perilla and soybean. Many of them are regionalized.

By multiplicity and by results obtained, the selection of oil-bearing crops in USSR is considerably ahead of capitalistic countries in this selection work. It is enough to say that from 78 regionalized varieties of oil-bearing crops 75 are of Soviet selection, and only 3 are the local varieties.

Regardless of successes which were achieved, there is yet serious work in the future to develop still more perfected varieties, which will fully answer all the varied requirements of a great mechanized socialistic agriculture and industry.

The September Plenum TsK of KPSS has put before the selection institutions a problem to develop and introduce into production new varieties of oil-bearing plants which are high in oil content, early-ripening, and resistant to disease. In order to successfully achieve this aim it is necessary to utilize Michurin's teachings constructively, and to strengthen the bond of scientific-research

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and selection institutions with kolkhoz-sovkhoz production.

The great transformer of nature, Ivan Vladimirobuch Michurin, wrote: "I see well and know thoroughly, that everything is - in movement, and I never find rest in that which was created before me or apart from me, as well as in that which I myself have achieved. When I have a certain aim in view, I do not squander my energies in different directions, but concentrate on this one purpose, and having achieved it, I go further from there to a new tempting aim." (1)

Following I.V. Michurin's directions, Soviet selectioners will achieve new successes, will develop more perfect varieties and thus contribute to the creation of plenty of agricultural products in our country.

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(1) I.V. Michurin. Works, V. IV, 1948, p. 266.

Donskaia Experiment-Selection Station for Oil-bearing Crops in the city of Rostov-on-Don.

VM/BN
July 26, 1956

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Sokolov, B.P.

Gibridy kukuruzy.

[Corn hybrids.]

Moscow, Sel'khozgiz, 1956. 141 p.

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(In Russian)

Chapter 8 (p. 105-118)

PRODUCTION OF HYBRID CORN SEEDS

A 719

Hybrid seeds of corn differ from seeds of ordinary standard varieties by one peculiarity, namely that the period of their utilization in production plantings is limited to only one generation, which follows the crossing. Further reproduction of hybrid seeds is unsuitable, as already in the second generation they give a decrease of 15 to 20% in yielding capacity compared to the first. Such a peculiarity of hybrids necessitates a yearly growing of hybrid seeds; this required of kolkhozes and sovkhozes to arrange the isolated hybridization plots, which also are seed plots at the same time. Taking into consideration the great national economic importance of introduction of hybrids into the fields of kolkhozes and sovkhozes, and the role which hybrids must play in the near future in our agricultural economy, the Central Committee KPSS and Council of Ministers of USSR in 1955 have established measures of encouragement, which would guarantee the growth of areas under hybrid corn:

The Ministry of Agriculture of USSR has established the following order of production of seeds of hybrid corn:

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1. Selection stations and elite-seed growing farms produce elite seeds of parental forms of hybrids.
2. Raion seed farms propagate elites of parental forms.
3. Hybrid seeds of the first generation for production plantings are grown on isolated plots of hybridization in kolkhozes and sovkhozes.

(Begin p. 106)

Some changes have been introduced of late into the seed growing of hybrid corn in connection with the fact that in some sections and oblast' double interlinear hybrids were regionalized.

Title of Fig. 14. A scheme for production of seeds of double interlinear hybrids of corn. Legend, reading from top to bottom: Line 2, Line 1, Line 3, Line 4.

(1 x 2) seeds of ordinary hybrid (3x4) seeds of ordinary hybrid.

Plant of an ordinary hybrid (1x2). Plant of an ordinary hybrid (3x4).

Maternal plant. Paternal plant. Production plantings with seeds of double hybrids.

(1x2) x (3x4) Seeds of a double hybrid for plantings on farm areas.

Selection stations propagate on isolated plots the lines which take part in crossing, and grow on hybridization plots the first generation of ordinary interlinear hybrids--maternal and paternal forms of interlinear hybrids.

Simple interlinear hybrids are propagated on elite farms by way of ordinary reseeding of seeds of the first generation on isolated plots; a result of which is the obtaining of a yield of the second generation of simple interlinear hybrids.

Raion seed farms, which by planting the second generation of simple interlinear hybrids obtain a yield of the third generation, which then goes to the plots of hybridization (Begin p. 107) into kolkhozes for a yearly raising of seeds

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of the first generation of double hybrids.

A scheme of organisation of seed growing for double interlinear hybrids is presented in the following form.

Scheme of seed growing for double interlinear hybrids of corn.

Selection stations	A plot for hybridisation in order to obtain seeds of a simple interlinear hybrid- of the maternal form of a double interlinear hybrid.	A plot for hybridisation in order to obtain seeds of a simple interlinear hybrid- of paternal form of a double interlinear hybrid.
Elite farms	Sowing of seeds of the first generation of the maternal form of a double hybrid.	Sowing of seeds of the first generation of the paternal form of a double hybrid.
Raisemkhozy [Raion seed farm]	Planting seeds of the second generation of the maternal form of double hybrids.	Planting seeds of the second generation of the paternal form of double hybrids.
Kolkhozes	Plots for hybridisation in order to obtain seeds of the first generation of double interlinear hybrids. Production areas planted to seeds of the first generation of double interlinear hybrids.	

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The cited scheme gives a descriptive presentation, showing that seed growing of double interlinear hybrids in raisovkhozes and kolkhozes is not more complicated than the seed growing of intervariety hybrids and does not call for additional expenditures. The difference is only in the composition of parental forms for hybridization. If for obtaining intervariety hybrids in kolkhozes ordinary varieties are sown, then for obtaining double interlinear hybrids simple hybrids are sown as paternal and maternal forms. The full load of work in seed growing for double interlinear hybrids rests on selection stations and on elite farms. They must create and propagate self-pollinated lines and obtain, by means of crossing the lines, seeds of simple interlinear hybrids, which are propagated in seed growing farms by way of the usual reseeding and, further on, enter the plots of hybridization in kolkhozes and sovkhozes. (Begin p. 108)

Growing of hybrid seeds on plots for hybridization in kolkhozes and sovkhozes.

In order to prevent any biological contamination, the hybridization plots should be placed at a distance of 200 m from other corn plantings.

Hybrid seeds must be grown, without fail, on a high agrotechnical background (a deep autumn ploughing, double preplanting cultivation, introduction of fertilizers).

It is not allowed to change locations for parental forms, that is, plant on hybridization plots a maternal form instead of the paternal.

Seeds of parental forms must match their variety designation and in their sowing properties answer the established conditions.

Planting

When planning the sowings it is necessary to proceed from the basic problem--to obtain from each unit of area the maximum yield of high grade hybrid

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seeds. That is why the number and alternation of rows of maternal and paternal rows must be such as to utilize in the best possible way the land acreage, to guarantee full pollination of maternal plants by the pollen of the paternal form, rationalise all the processes, which are connected with hybridization and take care of the plants on the hybridization plot.

The Ministry of Agriculture of USSR, up to 1948, recommended for growing hybrid seeds a method of planting where the ratio of rows of the maternal form and the paternal was 2 : 1. With such a distribution the number of maternal rows comprised 2/3, and of paternal 1/3 of the whole amount of rows.

In 1948, (in view of a proposition by individual selectioners to situate the maternal and paternal plants on hybridization plots in alternate rows, that is in a ratio of 1 : 1) we arranged an experiment for obtaining hybrid corn seeds of the hybrid "Uspekh" with different ratios of rows of parental forms. The first variant--2 rows of variety Dnepropetrovskaia alternating with one row of (Begin p. 109) Grushevskaia 380 (2 : 1); the second variant--Dnepropetrovskaia and Grushevskaia 380 are planted in alternating rows (1 : 1).

For the second variant the plot was divided across the rows in two equal parts; on one part all the maternal plants were three times additionally pollinated by the pollen of Grushevskaia 380 corn; on the other part of the plot additional pollination was not conducted.

The cobs of both variants of the experiment were harvested and kept separately until planting time. In the spring of 1949 a planting was done on sections of an area of 100 sq. m. with a triple replication in order to test the obtained hybrid seeds. Data of yields in 1949 are given in table 30.

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Table 6.

Comparative yielding ability of hybrid seeds of corn depending on methods of growing.

Name	Conditions for obtaining hybrid seeds in 1948		Yield of grain in 1949 (c/ha)
	Ratio of maternal rows to paternal	Additional pollination	
Hybrid Uspekh (first generation).....	2 : 1	was not applied	24.2
Same.....	1 : 1	was applied	24.7
Same.....	1 : 1	was not applied	25.0

As seen from table 30, the difference in yield among individual variants is in the limits of exactness of the test, and that is why it cannot be held trustworthy.

The sowing of hybridization plots in 1948 (with ratios of maternal and paternal rows of 2 : 1 and 1 : 1) did not affect the yielding properties of hybrid corn seeds in 1949. That is why, if paternal plants have normal and well developed panicles, it will be economically sound to plant for hybridization maternal plants in ratio to paternal as 2 : 1.

Instructions of the Agricultural Ministry of USSR recommend conducting the sowing of maternal and paternal rows of plants in a ratio 2 : 2 in order to (Begin p. 110) provide maternal corn plants on hybridization plots with sufficient amount of pollen from paternal plants. Such a ratio of maternal and paternal rows is convenient also when conducting the work of removing the panicles from maternal plants.

During one passage it is possible to remove panicles from plants in both

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rows, which is impossible to do with alternating rows.

Title of Fig. 15. General view of a hybridisation plot.

Since 1951 the Ukrainian Scientific-Research Institute of Grain Economy is conducting, as an experiment, plantings with alternation of maternal and paternal rows in ratio of 2 : 1. In order to increase the amount of pollen from the plants-pollinators, during the thinning we leave in every hill two plants of the paternal form and only one plant of the maternal. The scheme of placement of plants, when sown by a drill seeder looks as follows (see page 111).

With such a method of sowing the ratio of the number of maternal and paternal plants (2 : 3) is retained, but the yield of hybrid cobs is harvested from 2/3 of the area of the hybridisation and not from half of it.

For growing hybrid seeds the sowing in kolkhozes is done by hand planters or by a check-hill (sentence continued on p.111 after the scheme) (Begin p. 111)

Scheme for sowing corn on a hybridisation plot, according to a method of UNIIKH [Ukrainian Scientific-Research Institute of Grain Economy.]

(•) (••) (•) (•) (••) (•) (•) (••) (•) (•) (••) (•)
(•) (••) (•) (•) (••) (•) (•) (••) (•) (•) (••) (•)
(•) (••) (•) (•) (••) (•) (•) (••) (•) (•) (••) (•)
(•) (••) (•) (•) (••) (•) (•) (••) (•) (•) (••) (•)

(•) Maternal form—one plant per hill

(••) Paternal form—two plants per hill

drill seeder SSh-4A with a measuring wire, designed so that two rows of paternal forms alternate with two rows of maternal forms as it is shown in the scheme:

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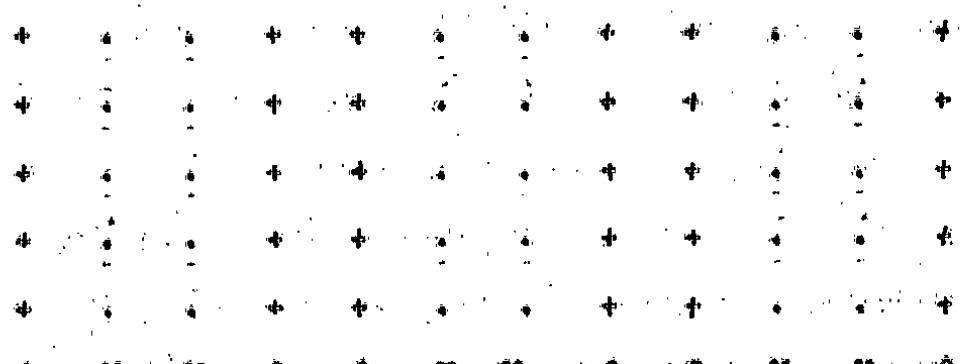
The accepted scheme for planting corn on hybridization plots in kolkhozes:



O M M O O M M O O M M O

M--maternal forms, panicles are removed, plants are pruned;

O--paternal forms, panicles are not removed, plants are not pruned.

With this method of sowing the stoking of seeds of parental forms of corn into the drill seeder SSh-6A with a measuring wire is made in the following manner:

Seeds of the paternal form	Seeds of the maternal form	Seeds of the maternal form	Seeds of the paternal form	Seeds of the paternal form	Seeds of the maternal form
O	M	M	O	O	M

The drill is set to the norm of sowing according to the largest grained parental form depending on the absolute weight of seeds and the region of growing. Sowing is done on the best dates, and into a well warmed soil.

In order to later be able to distinguish the rows of maternal forms from the paternal, to the seeds of corn of the paternal form is mixed in a small amount (Begin p. 112) of germinating sunflower seeds (up to 0.5% of the weight of corn). When corn is thinned the sunflower sprouts are left in paternal rows at a distance of 10-15 m one from the other.

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Care of the plantings.

Caring for the plantings on plots for growing of hybrid seeds of corn, until the moment of appearance of male inflorescences, basically does not differ from the care of ordinary corn plantings. In regions where rooks and gophers harm the corn sprouts, it is necessary to pay attention to protection of plantings from these pests.

Thinning should be done during the phase of 3-4 leaves. Area of feeding under one plant must be increased by 15-20% against the accepted one for production plantings in the given region. Widening of the area of feeding guarantees obtaining of stable yields during the years with a shortage of rain and increases the yield of seed cobs. During the period of care the needed number of interrow cultivations must be carried out.

Hybridization.

Hybrid seeds of corn are obtained as the result of fecundation of female flowers of the maternal form by the pollen of paternal plants. This is achieved by removal of all male inflorescences, the panicles on plants in maternal rows before the beginning of flowering. The female inflorescences of plants of maternal rows, deprived of panicles are pollinated by the pollen, which is borne by the wind, from only the blooming panicles of plants in paternal rows. In this way is achieved the full crossing of the maternal form with the paternal.

Detasseling of plants in maternal rows is the most responsible work for obtaining hybrid seeds. The yielding qualities of hybrid seeds depend on the timely and accurate detasseling.

Detasseling must begin at that moment when the tops of the panicles emerge from the unfurled upper leaves and they can be caught by the hand. The worker, walking through the interrow looks over both the maternal rows and by a brisk

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movement of the hand up removes the panicle together with a part of the pedicle. During a well timed removal of panicles (Begin p. 115) they break off at the last node, without leaves. In separate cases, especially during shortage of moisture, a part of the plants begins to bloom at the time when the panicles did not as yet become free from the upper, covering leaves. In these cases they must be freed from the leaves and removed before blooming.

Title of Fig. 16. Correct removal of a panicle.

The period of ejecting the panicles in corn is spread out for 10-15 days. It is impossible to remove them on the maternal form in the course of 1-2 days. That is why they are removed daily, as they appear, until that time when they will be removed from all plants of maternal form.

When there will remain unremoved not more than 10% of panicles on plants of maternal forms, they should be taken off in one day, even if one had to tear off for this the upper covering leaves of the panicles. The removed panicles are piled into small heaps on the edge of the plot and are daily taken away to be utilized on the farm.

The plants of the maternal rows must be pruned without fail, because the side shoots may develop panicles too. The plants in the paternal rows must not be pruned. They will give additional pollen. (Begin p. 114)

For the whole period of work, from the beginning of the ejection of panicles, it is necessary to assign to the hybridization plot permanent workers at the rate of one man per 1.5-2 ha of plantings (table 51).

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Table 31.

Calculation of the time spent for detasseling

on hybridization plots

(Sinelnikovskaia Selection-Experiment Station, 1952.

Area 1.72 ha.)

Date of detasseling	Number of removed panicles	Expenditure of hours
15/VII	1410	8 hours
17/VII	2087	10 "
19/VII	2581	10 " 40 min.
21/VII	2480	10 " 30 "
24/VII	1486	7 "
26/VII	1667	8 "
28/VII	849	5 "
31/VII	1481	6 "
2/VIII	756	4 " 30 "
5/VIII	214	2 " 20 "
7/VIII	187	2 "
Total.....	15,177.	75 hours

A certain number of rows must be assigned to each of these workers for the whole period of detasseling.

The one who is responsible for the hybridization plot (field team leader, or brigade-leader) controls the quality of work of each member of the team and daily, after the end of work accepts it.

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Harvesting.

Harvesting is begun at full ripening of the seeds. It is not permissible to let the ripe corn stand in the field for a protracted time, as overripe corn cobs are affected by fungous diseases.

Harvesting is done in two stages. At first are harvested the cobs from maternal rows. The harvested cobs of the maternal plants are carried to the edge of the plot; and when the rows are very long, onto areas especially (Begin p. 116) cleared from corn stalks; from here they are hauled to the place of sorting.

The seeds from the cobs of maternal rows are a valuable hybrid seed material, which will be used next year for planting on production areas in kolkhozes and sovkhozes in order to increase the yielding capacity.

The cobs from the plants of paternal rows are harvested in the second turn, after the hybrid seed cobs are removed from the field.

Together with the gathering of the paternal cobs are picked up those maternal cobs which fell to the earth from the stalks.

The cobs of the paternal forms and those which went down from the stalks of maternal forms are not seed material and are used for farm needs.

Storage and drying of seed corn.

The seed corn cobs, which were harvested from the hybridization plot are stowed in "Koshi" (light type constructions for corn storage), in covered threshing floors, or in lofts of good ventilated buildings. The thickness of the layer of corn cobs should not exceed 30-60 cm in closed quarters, depending on moisture content, and in Koski 1-1.5 m.

Sorting the seed cobs should begin immediately after harvesting and as

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fast as possible. The evidently unripe ones, those affected by fungous diseases, as well as cobs of different varieties are removed during preliminary sorting. It is also imperative to carefully remove all the remaining husks and silks, because they hamper the drying of seed cobs. The problem of the preliminary sorting is to free the seed material from wastes which encumber the drying.

Cobs of medium size and even the small ones which are not always well filled out, but which have healthy seeds, should not be discarded, because their seeds, being hybrid, will bring high yields after sowing.

The previously sorted cobs must undergo a drying up to a conditional moisture content which is up to 16%. Drying must be finished in as short a period as possible and not later than the beginning of frosts.

After drying the seed cobs must undergo a second, final sorting. At this time are rejected (Begin p. 11a) all diseased cobs, also cobs with sickly and lightweight seeds and all the variety adulterations. As during the first sorting, the middle size and the small size cobs with healthy, well-developed seeds are not rejected.

The sorted seed material goes through storehouse approbations, and if it satisfies the planting and variety conditions it is then delivered to the procurement center.

If hybrid seeds are intended for planting in one's own farm, then they are stored on cobs in dry, well ventilated places, and always separately from other lots of corn in order to evade mixing the varieties.

Plantings of corn, which are intended for the propagation of hybrid seeds are subject to twofold field observations during detasseling, as well as field and storehouse approbations, according to special instructions of Ministry of Agriculture of USSR.

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Approbation of plantings on plots of hybridization and on plots of propagation of parental forms.*

* See the provisional directions on growing seeds of hybrid corn and of their parental forms, Izd. MSKh USSR, 1953.

1. Spatial isolation for hybridization plots and for plots of propagation of parental forms should be established for a distance of not less than 200 m.

When such isolation space is not provided, part of the crop, which grows in the isolation space, should be rejected as seed material.

2. During propagation of selfpollinated lines and growing of the first generation of simple interlinear hybrids it is absolutely necessary to conduct variety weeding, also a careful twofold examination of all plants during the period before blooming and a removal of all admixtures--clearly atypical and hybrid plants, which are distinctly different in height, time of blooming, and so on.

3. The field approbation is conducted on all plantings for propagation of parental forms (varieties of selfpollinated lines and of parental simple interlinear hybrids of the second, third and fourth generations) according to the existing method of approbation of variety sowings of corn. (Begin p. 117)

On hybridization plots approbation is not conducted, but is substituted by a compulsory field examination of the quality of work of detasseling, which is conducted by an agriculturist-approbator.

Results of examinations are recorded in a document of field observations of corn plantings on a hybridization plot (Form no. 1).

Plantings with hybrid seeds on production areas, which are not intended

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for seed purposes, are not approbated, but must be registered as variety sowings.

4. Panicles of maternal plants on hybridization plots must be fully removed before the beginning of blooming.

If on a hybridization plot during two examinations will be uncovered over 5% of panicles removed before blooming, the question of a possibility of utilization of hybrid seeds from such plantings is settled by the oblast' (regional) agricultural administration or the Ministry of Agriculture of the Republic.

On selection stations and elite-seed growing farms, on plots for growing seeds of the first generation of simple hybrids, the presence of maternal plants with panicles unremoved before blooming is not tolerated.

5. The course of a field examination of the quality of detasseling on hybridization plots is set as follows: 10 points are chosen on a diagonal line, and in each of them 50 maternal plants are examined one after another.

Storehouse approbation of seeds of hybrids
and of their parental forms.

1. Storehouse approbation of hybrid seeds and seeds of parental forms is conducted after the sorting of cobs.

During storehouse sorting of cobs of parental forms of intervariety and variety-linear hybrids it is necessary to be guided by the instruction on approbation of variety plantings.

When cobs of selfpollinated lines are sorted, as well as cobs of simple interlinear hybrids, the small cobs with normally developed healthy seeds are not rejected, even when there are empty places present there. The cobs which should be rejected are those which have atypical seeds in varietal properties (color and consistency of the seed, color (Begin p. 116) of the stem, of the cob),

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sick and ailing cobs, and for lines, besides this, atypical in size and shape.

2. Seeds of selfpollinated lines must have 100% of cobs of the basic type and not more than 10 xenia seeds per 100 cobs.

Seeds of simple interlinear hybrids during field approbation must have a varietal typicalness not lower than 99.6% and not more than 100 xenia seeds per 100 cobs, and after storehouse sorting--one hundred per cent of varietal typicalness and not more than 10 xenia seeds per 100 cobs.

3. A certificate for hybrid corn seeds (form no. 2) is issued for hybrid seeds of the first generation.

For seeds of parental hybrid forms (varieties, selfpollinated lines and simple interlinear hybrids of the second, third and fourth generations) the usual seed attestations are issued, or the usual variety certificates.

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Translation A-720
(In full)
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Chalyk, T.S.

Opyt ispol'zovaniia mestnykh moldavskikh sortov kukuruzy dlia mezhlinejnoi gibridizatsii.

[Experimental use of local Moldavian maize varieties in interlinear hybridization.]

In Kishinevskii Sel'skokhoziaistvennyi Institut imeni M.V. Frunze. Sbornik rabot po izucheniiu kukuruzy v Moldavii, pp. 201-211. Moskva, Sovetskaia Nauka, 1955. 59.22 K64

(In Russian)

A 120

The advantage of sowing hybrid seed has been evidenced by numerous experimental and industrial data. Special interest is presented by the double composite hybrids which under similar cultural conditions ensure a 10-15 centners per ha yield increase, as compared with standard varieties.

Beginning with the year 1953, we have tested in our experiments the double interlinear hybrid VIR-42. Compared to the standard variety, Dnepropetrovskaia, the hybrid VIR-42 produced in 1955 an increase in grain yield amounting to 8.3 c/ha, and in 1954--5.6 c/ha (table 1).

Table 1.

Productivity of hybrid VIR-42 compared to the standard[variety] and to local Moldavian varieties

No. in consec. ord.	Name of variety	1955		1954	
		Grain yield c/ha	% of standard	Grain yield c/ha	% of standard
1	Standart Dnepropetrovskaia	20.5	100	30.0	100
2	Hybrid VIR-42	29.0	142	35.6	112
3	Mold. sheltaia	18.2	89	-	-
4	Mold. cranzhevaia	16.7	82	-	-
5	Poluzubovidnaia	16.5	81	-	-
6	Portokaliu	11.6	57	-	-

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Interlinear hybrids, however, are not easily distributed in production for the following reasons:

1) the intricacy of obtaining hybrid seed, since the original self-pollinated lines lack vitality, produce a poor yield and are selective as to external environment. Hybridization requires strict isolation of hybridization plots and careful removal of male tassels prior to flowering;

2) double VIR hybrids contain a high percentage of starch, a reduced percentage of albumin and fats and are better suited for industrial purposes. The VIR-42 hybrid is distinguished by fragile stems below the ear which contributes to loss of yield and complicates work if the crop is left standing even a little while after it has ripened.

Moldavian local flint varieties (Mold. oranzhevaia, Mold. zheltaia, Portokalilli) have a higher content of albumin and carotin than dent interlinear hybrids of VIR [All-Union Institute of Plant Industry]. In this respect much has been done by native Moldavian selection. The population which for an extended period had lived on homony, picked from the existing varieties maize forms with a higher albumin content.

In 1961, under the guidance of Professor A. E. Kovarskii, we began work on the production of highly productive interlinear, or lineal-family, maize hybrids by crossing self-pollinated lines obtained from local flint varieties with dent self-pollinated lines.

Such hybrids must be highly productive inasmuch as they have been crossed with dent and flint lines and families which vary in a series of properties; they must be adapted to local external conditions; they must be drought resistant, inasmuch as forms which come from local, time-honored Moldavian varieties have participated in the crossing; they must be flint or, if need be, semi-dent

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with a high content of albumin and carotin.

Material and method of investigation. The flint and semi-dent local varieties included in the experiment were as follows: Moldavanka zheltaia KSKHI [Kishinev Agricultural Institute], Moldavanka oranzhevaia, Portokaliu, Chinkvantino and Poluzubovidnaia [semident] (local natural hybrid from dent varieties and local flint varieties obtained as a result of adaptation of dent varieties to Moldavia (Kovarskii)).

To create more contrasting lines, we conducted self-pollination of the dent varieties Sterling and Dnepropetrovskaia.

At first it was necessary to produce, evaluate and select the best self-pollinated lines for their further repeated self-pollination, for study and crossing.

Plants for their self-pollination were grown on a superior agricultural background and were sown from selected seed of the variety. Self-pollination was carried out on the best and healthiest plants. Two to three hundred plants of each variety were used in forced self-pollination. Isolation of male tassels and stigma was achieved by dressing them in special parchment isolators. The ears were isolated before stigmas appeared on them, but male tassels only when their main axis began to bloom. When the stigma came out of the ear wrapping, and the tassel began to dust, the latter was cut off with 20-30 cm long pedicel [nozgka] and was transferred to the pistillate silk. [Begin p. 203]

For pollination the isolator was removed from the pistillate silk very carefully and quickly, and in its place was slipped on another isolator together with a male tassel. The tassel pedicel was sharpened at the end and was placed in the axil of the leaf. The moisture in the axil of the leaf kept the tassel

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for some time in a turgid state, and it gave further pollen.

Pollination was accomplished in the morning hours (from 8-11) when pollen has greater vitality.

Fig. 1. Self-pollinated maize lines isolated from the Moldavian Chinkvantino variety.

Most of the ears obtained after artificial self-pollination were sparsely covered with grain, but their seed were larger.

The following year the seed of each ear were sown alongside of their number in the nursery for self-pollinated lines--2-3 rows (5-10 M^2) of each line--separately for study and repeated self-pollination. For comparison, the original variety was seeded between every 10 line numbers.

Most self-pollinated lines had difficulty in sprouting. The plants were unable to break through the incrustation and while they continued to grow beneath it, they formed a long yellow-white etiolated shoot. In connection with this, seed of self-pollinated lines must not be buried deep in the soil when seeded.

Results of investigations of self-pollinated lines. Many self-pollinated lines have acquired all sorts of new characteristics, frequently at the expense of vitality:

1. Abnormal concentration and distribution of chlorophyll in the leaves. In some lines albino plants were prevalent, [Begin p. 204] some of them perished for lack of nutrient substances, but some began to turn green later on. Parallel with this there were noted lines with plants of a dark green, almost blue color (Mold. oranzhevaia 21, self-pollinated line of the first year, Poluzubovidnaia 22, a second year line of self-pollination), while others, on the contrary, were conspicuous because of their bright, light-yellow coloring (Poluzubovidnaia 36, a self-pollinated line of the 1st and 2nd years).

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Fig. 2. Self-pollinated maize lines isolated from the Moldavian Poluzubovidnaia variety

The line of Zubovidnaia 56 had bright, light-yellow leaves in 1953 and it retained this character in 1954.

Among some lines there was noted an intensive anthocyan coloring of a violet tone, either over the entire plant or only on the tassel.

2. Dwarf-like appearance of the whole plant or only of its separate parts.

3. Crimped leaves, completely or only on the margins.

4. As regards drought resistance the results vary: separate lines did not wilt during heat or drought, yet others wilted badly and perished completely.

In some lines the upper, more delicate part of the plant was beginning to burn out.

5. Many lines were inclined to lodge; particularly the self-pollinated lines derived from the Sterling variety; others, on the other hand, are very resistant to lodging and to fungus diseases.

Specially pronounced changes had taken place in the reproductive organs of self-pollinated lines:

1) multiple ears (individual plants from the self-pollinated lines of Chinkvantino had 5-7 ears, while others had only 2-3 ears);

2) appearance of female florets on the tassel;

3) formation of large, branching out tassels with a large amount of pollen and, then again, the presence of a very weak branchless tassel with a small amount of pollen, often semi-sterile.

Table 2 shows that in self-pollination there is a sharp drop in the productivity of one plant. The ear grows smaller, sparseness of grain increases, yet the weight per 1000 grains increases in the first year of self-pollination,

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which is due to the pronounced sparseness of grain. The line of Moldavanica oranzhevaia 26 (of 1st year self-pollination) produced almost all ears with branches.

Table 2.

Depression of self-pollinated lines of one, two and three years of self-pollination compared to original varieties.

No. in consec. ord.	Name of variety and self-pollinated lines	Height of plant in cm	Grain yield in gr per plant	Average weight of ear in gr.	Average number of grains on ear	Weight per 1000 grains in gr	Length of vegetative period in days
	1953						
1	Mold. oranzhevaia	202	94.7	115.0	542	190	104
2	Mold. 1st yr. self-pol. (aver. of 16)	166	55.6	85.8	359	192	107
3	Mold. 2nd yr. self-pol. (aver. of 5)	161	61.2	76.9	287	210	108
4	Mold. zheltaia - variety	170	99.8	109.0	520	160	100
5	Mold. 1st yr. self-pol. (aver. of 4)	152	22.5	98.6	456	150	108
6	Mold. 2nd yr. self-pol. (aver. of 4)	136	18.8	47.6	208	140	108
7	Poluzubovidnyi variety	206	97.0	172.0	802	206	106
8	Poluzubovidnyi self-pol. 1st yr. (aver. of 7)	175	57.6	127.0	415	218	108
9	Dnepropetrovskaia - variety	186	107.0	141.0	605	210	103
10	Dnepropetrovskaia 1st yr. self-pol. (aver. of 6)	144	58.0	64.0	275	185	108
11	Dnepropetrovskaia 2nd yr. self-pol. (aver of 6)	141	58.0	65.1	275	165	109
12	Sterling - variety	190	97.0	157.0	539	238	105
13	Sterling 1st yr. self-pol. (aver. of 7)	174	76.6	114.6	357	262	105
14	Sterling 2nd yr. self-pol. (aver. of 7)	137	40.3	47.6	150	220	109
	1954						
1	Mold. oranzhevaia 3rd yr. self. pol.	191	7.0	30.0	395	130	98
2	Mold. Zheltaia 3rd yr. self-p	190	14.0	31.0	-	-	-
3	Poluzubovidnaia 2nd yr.self-p	217	65.0	92.0	389	204	90
4	Dnepropetrovskaia 3rd yr. self-pol.	186	90.0	77.0	440	203	88
5	Sterling 3rd yr. self-pol.	140	30.0	50.0	-	-	106

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It must be emphasized that as a result of self-pollination there appeared entirely new plant forms which heretofore had not been discovered in the original variety. [Begin p. 206]. In the opinion of A.K. Kovarskii, these properties appeared as a result of the preceding culture in which diverse cell properties developed. Characters which had been in a recessive state could develop rapidly as a result of self-pollination, under concrete cultural conditions.

While self-pollinating plants of the same family, we obtain the most diverse forms in the progeny. Some lines give uniform [vyravnennye] plants immediately upon a year's self-pollination. The lines, however, usually become more uniform in the second or, more often, in the third year of self-pollination.

As a result of self-pollination and concrete cultural conditions differentiation of variety in a line is possible in any year.

Most of the newly emerged forms are hereditary. It is known that heredity and vitality are different properties. Heredity of any variety whatever may lack vitality if we subject it to forced self-pollination (in crossed varieties [u perekrestnikov]), yet, on the other hand, its vitality may be high in free pollination with a wide range of possibilities of selective fertilization.

It must be emphasized that most selectioners conducting maize selection by means of crossing self-pollinated lines (Sokolov (3), Khadzhinov (4), Kozhukhov, Kibizov, Kozubenko and others) declare that it is necessary to subject a line to 3-4 repeated self-pollinations before the whole line becomes uniform, and that only after this, lines undergo crossing among themselves. We, however, tried to do this sooner so as to study the properties of inbred lines.

In 1952 and 1955 pair crossing was conducted among the uniform lines of the first and second years of self-pollination in order to obtain simple [prostykh]

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self-pollinated hybrids. Crossing was conducted by isolating the female ears with parchment isolators and by dusting them with the pollen collected from one plant or several plants of another self-pollinated line. Upon the suggestion of A.S. Kovarskii, crossing, as a rule, was conducted among those self-pollinated lines of the original varieties which produce good results in inter-varietal hybridization. To increase the contrast of pairs in crossing, lines with dent grain were repollinated with lines having grain of the flint type, and pairs were selected on the principle of parent distinction as to vegetative and generative characters. In the spring the hybrid seed were sown in the field.

In 1953, for reasons of comparison, an intervarietal hybrid of the same combination was sown alongside of each self-pollinated hybrid. In 1954 the hybrids were compared with the VIR-42 hybrid and the standard Dnepropetrovskaia as to productivity.. Data in table 3 indicate that most of these hybrids had displayed a sharply increased heterosis [Begin p. 209] and high productivity, surpassing by far that of the standard Dnepropetrovskaia and its close second in yield, VIR-42.

Fig. 3. Self-pollinated maize lines isolated from the Moldavian variety Moldavanka cranshevaia ESSHI [illus. shows size of original variety and of self-pollinated lines].

Fig. 4. Self-pollinated maize lines isolated from the selection variety Dnepropetrovskaia [size of original variety and of self-pollinated lines].

Fig. 5. Scheme of crossing the self-pollinated line Portokaliu 11 with the self-pollinated line VIR-116.

Fig. 6. Scheme of crossing the self-pollinated line Portokaliu 1 with the self-pollinated line VIR-116.

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Everything that has been said above permits us to drew the following general conclusions:

1. By means of self-pollination it is possible to differentiate local variety populations into different new forms (lines).

Fig. 7. Scheme of crossing the self-pollinated line of Portokalin 11 with different self-pollinated lines of VIR.

2. By selection of flint, drought resistant and early ripening lines and by crossing them with dent lines it is possible to obtain hybrids of self-pollinated lines which by far exceed the productivity of the intervarietal hybrid and standard [variety]. The new hybrids obtained are distinguished by their good qualities, they contain more albumin and are better suited for fodder purposes than the dent types.

3. Self-pollinated lines of local flint varieties, even after the first year of self-pollination, manifest a strong depression of the vegetative part of the plant and are much less productive than the original parent forms, but after they have crossed among themselves, productivity of the hybrids by far exceeds that of the standards and all better inter-varietal maize hybrids. [Begin p. 211]

4. In the future, crossing of the better simple linear hybrids will make it possible to produce double composite inter-linear hybrids. This will eliminate the difficulties involved in their seed growing. In the light of E.M. Galiagva's and A.M. Kovarskii's last works, it simultaneously will make it possible to eliminate depression in self-pollinated lines by means of influence exerted by the mentor of alien pollen, and by virtue of this circumstance it will put before selectioners the task of creating highly productive single hybrids for their practical use.

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Table 5.

Productivity of inter-linear hybrids of one and two years of self-pollination of the original lines as compared with inter-varietal hybrids

No. in succession order	Name of hybrids	Plant height in cm	Productivity of ear in gr. per plant	Average weight of ear	Number of grains in ear	Weight per thousand grains in gr.	Vegetative period in days	Yield of ears in c/ha
1	Sterling x Mold. oranzhevaia intervarietal hybrid	187	89	152	549	238	106	29.6
2	Sterling x Mold. oranzhevaia interlinear, average of several hybrids	211	148	156	532	235	108	38.6
3	Mold oranzhevaia x Sterling intervarietal	190	100	158	548	185	106	26.9
4	Mold. oranzhevaia x Sterling interlinear	209	134	142	518	206	106	31.9
5	Mold. oranzhevaia x Polyzubovidnaia intervarietal	193	101	144	541	220	106	30.5
6	Mold. oranzhevaia x Polyzubovidnaia interlinear	187	125	146	520	208	106	41.0
7	Dnepropetrovskaia x Mold. shaltaia intervarietal	186	111	139	515	240	106	32.0
8	Dnepropetrovskaia x Mold. shaltaia interlinear	191	153	152	549	260	106	45.8
	1954							
1	Interlinear hybrid VIR-42	-	168	-	-	-	100	49.5
2	Standard Dnepropetrovskaia	-	128	-	-	-	96	38.0
3	Dnepropetrovskaia 49 I_1, self-pollinated 1 yr x Mold. oranzhevaia 1 yr self-pollinated	-	175	152	300	290	108	49.8
4	Dnepropetrovskaia 10 I_2 x Mold. shaltaia 12 2nd yr.	-	152	120	560	210	94	49.9
5	Dnepropetrovskaia 49 I x VIR 108		152	117	490	280	106	41.1
6	Portokalia 11 I x VIR 116		248	165	760	216	110	57.8

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Trans. A - 721
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Stoletie so dnia rozhdeniia I. V. Michurina

[Centennial since the day of birth of I. V. Michurin]

Agrobiologiia, no.6, p. 146 - 147, Nov./Dec. 1955.
20 Ag 822

(In Russian)

The Soviet people, as well as all progressive humanity, have widely marked the centennial since the day of birth of the great transformer of nature, the eminent scientist-biologist Ivan Vladimirovich Michurin.

On October 27, in the Bolshoi theatre USSR, a grand meeting of the Academy of Science of USSR was held together with the All-Union Academy of Agricultural Sciences in the name of V. I. Lenin and with representatives of ministries, scientific institutions and agricultural leaders.

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On the centennial were present the most noted Soviet scientists, agriculturists, zootechniciane, innovators and leaders of kolkhoz and sovkhoz production, who came from all over the country; scientist-followers of Michurin from China, Poland, Czechoslovakia, Hungary, Roumania, Bulgaria, Albania, German Democratic Republic, Korean People's-Democratic Republic, Vietnam, France, Yugoslavia, Japan, Pakistan, Switzerland, Belgium, and other countries.

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In the Presidium of the meeting were Comrades N. A. Bulganin, K. E. Voroshilov, L. M. Kaganovich, G. M. Malenkov, M. G. Pervukhin, M. Z. Saburov, N. I. Beliaev, D. T. Shepilov, substitute of the Chairman of the Soviet of Ministers USSR P.P. Lobanov, Minister of Agriculture in USSR V.V.Matskevich, Minister of Higher Education in USSR V. P. Eliutin, Minister of Culture in USSR N.A.Mikhailov, Secretary of MK KPSS [Moscow oblast' Committee of Communist Party of Soviet Union] I. V. Kapitonov, Secretary of MGK KPSS [Moscow City Committee] E. A. Furtseva.

The grand meeting was opened with an introductory word from the President of the Academy of Science of USSR, Academician A. N. Nesmeianov.

"The great Lenin has discovered Michurin," said Academician A. N. Nesmeianov. The way in which Michurin entered into the history of modern natural science he could become only thanks to the care and generous help of the Communist Party, of Soviet State; thanks to those conditions, which were created by the socialist regime for the development of the scientific thought.

I. V. Michurin's centennial is noted by scientists of our country as an important date in history of natural science, as a bright landmark on the way of scientific darings in the knowledge of the laws of life, in their utilization for the transformation of the living nature for the benefit of mankind.

The Presidium of TsK KPSS [Central Committee] was very enthusiastically elected as an honorary presidium of the grand meeting.

A report on a theme: "One hundred years since the day of birth of an eminent scientist-biologist I. V. Michurin" was given by the

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President of the All-Union Academy of Agricultural Sciences in the name of V. I. Lenin, Academician T. D. Lysenko (the report is published in this issue of the journal "Agrobiologia").

A scientific session of the All-Union Academy of Agricultural Sciences in the name of V. I. Lenin, with the participation of the Institute of Genetics of the Academy of Science of USSR, of the All-Union Institute of Animal Husbandry and other scientific institutions, institutions of higher education and of agricultural leaders, which was dedicated to Michurin's centennial took place in Moscow from October 28 to November 2.

About two thousand people took part in the plenary and sectional meetings - scientists, agricultural leaders, Michurin-experimenters, as well as foreign scientists. Altogether 260 reports were made.

During plenary meetings reports on the following subjects were made: "About Michurin's legacy" (Academician P. N. Iakovlev), "I. V. Michurin - founder of creative Darwinism" (Academician I.I. Prezent), "Michurin's principles in selection of grain crops" (active member of the Academy of Science of Ukrainian SSR V. Ia. Iur'ev), "Varieties of agricultural crops of All-Union Order of the Labor's Red Banner of the Selection-Genetics Institute (Academician D. A. Dolgushin), "Achievements of selection in USSR" (P. E. Marinich), "Michurin's doctrine in animal husbandry" (Doctor of Agricultural Science, Professor I. M. Kuzmetsov), "Principles of I. V. Michurin's doctrine and new methods of increase of vitality and changes of inheritance in agricultural animals "(Doctor of Agricultural Sciences, Professor S. G. Davydov), "Michurin's doctrine in

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microbiology" (Academician S. N. Muromtsev), "About the unity of ideas in the doctrines of I. V. Michurin and of I.P.Pavlov "(Member-correspondent of Academy of Medical Science of USSR D. A. Birinkov), "Michurin and Siberian horticulture" (Doctor of Agricultural Sciences M. A. Lisavenko), "Opinions of Darwin and Michurin on the role of the environment in the variability of organisms" (member-correspondent of the Academy of Science USSR N.I. Nuzhdin), "I. V. Michurin's doctrine about fecundation of plants in view of new experimental data" (member-correspondent of Academy of Science of Ukrainian SSR I. M. Poliakov), "Development of Michurin's doctrine outside USSR" (Doctor of Biological Sciences, Professor I. E. Glushchenko). (Begin p. 147)

Foreign scientists came forward at the jubilee meeting with greetings and messages about the development of Michurin's movement in their countries: Tszu De-min (China), Antonina Klechka (Czekoslovakia), Ruzhitsa Glavinich (Yugoslavia), Kurt Sedl'mair (Hungary) , Klod Shari' Maton (France), Nikolai Stoianov (Bulgaria), Zhiumzhiro Kaakhara (Japan), S. Siddiki and Mohamed Sharif (Pakistan), Stefan Panenzhek and Iadviga Lekchin'skaia (Poland), Aleksandr Priadchenku (Roumania), Zhak de-Bomon (Switzerland), Adem Deliu (Albania), Sironval' (Belgium), Bui-Gui dap (Vietnam), Ken'iti Kikuti (Japan), Tsoi - chan Min (Korean People's-Democratic Republic) Shagdar Erdne Baatar (Mongolia), Togannes Rainkhal'd.

A whole series of salutatory telegrams was announced from foreign scientific institutions: Chinese Academy of Science, Hungarian Academy of Science, Bulgarian Academy of Science, Academy of Science of Korean

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People's-Democratic Republic, Yugoslavian Academy of Science, Academy of Science of Roumanian People's Republic, Albanian Institute of Agriculture and Biology in the name of I. V. Michurin.

During the final Plenum meeting young naturalists-michurinists and experimenters-michurinists came forward.

A large number of reports were made on sectional meetings.

Reports in conferences of the section of general biology were devoted to problems of species and their formations, to regularity of heredity in adquired properties, directed changes of properties and characteristics of plants, vegetative hybridization, theory of phasic development, biology and cytology of fertilization, biological problems of acclimatization of plants and animals on the basis of Michurin's methods.

During conferences of the section of plant growing were heard reports on grain crops, on hybrid corn varieties and on introduction of corn into new, northern regions, on bringing under cultivation of virgin and waste lands, on utilization of Michurin's doctrine in the selection of technical crops, of sugar beets, sunflowers, flax, tobacco, tea plants, fodder grasses, vegetable crops, potatoes.

The section of fruit growing and viniculture heard reports about the development of Michurin's doctrine in the works of Central Genetics laboratory in the name of I. B. Michurin, about the creative utilization of Michurin's ideas in fruit growing, about ways of development of horticulture in new regions, about Michurin's principles in selection of fruit and berry crops, grapes, about liquidation of periodicity of fruit-bearing of apple trees, and so on.

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During conferences of the section of animal husbandry and veterinary science reports were made about methods of increase of productiveness of big cattle on production farms, about new methods of increasing the vitality of the animal organism, about Michurin's principles in the work of improvement of the existing and creation of new high-productive breeds of agricultural animals, about the disturbance of metabolism in milch cows and ways of its elimination, and others.

Reports which were made during conferences of the section of microbiology were dedicated to problems of species development and directed variability of microorganisms, variability of pathogenic viruses, improvement of soil feeding of plants on the basis of regulation of the activity of soil microorganisms, utilization of bacterial fertilizers, and other topics.

-A group of the session's participants and of foreign guests visited the Michurin's city. There they inspected the scientific institutions and laid a wreath on the grave of the eminent scientist.

Meetings of the biological section of the Academy of Science of USSR were dedicated to Michurin's centennial, as were also the scientific sessions of the Academies of Science of allied republics, the jubilee meetings of scientific committees of scientific-research institutions and of higher educational institutions. Reports and lectures on Michurin were read all over the country in concerns, in kolkhozes, sovkhozes, and machine-tractor stations. Michurin's evening festivities were arranged in schools, raion houses of culture, on experiment stations, and on variety-test stations.

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The Central Scientific agricultural library of VASKhNIL, together with USSR Library in the name of V. I. Lenin has organized a large exposition of Michurin's works and of literature about him for this important occasion.

In many raions there were gatherings of youthful naturalists. On October 27, many republican, oblast', regional and raion newspapers came out with special Michurin pages. Among other materials, here were published articles of workers in scientific-research institutions, appearances of Michurin-experimenters, recollections of friends and co-workers of Michurin. The greater number of agricultural journals published special Michurin's issues.

In many oblast' and republics special garden weeks and months were conducted.

In Kaunas on territory of Vitensky garden-vegetable station a memorial to the eminent scientist-biologist was unveiled with great solemnity. Michurin's centennial took the form of a popular demonstration of unity of science and practice, of a review of successes of the materialistic biological science.

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Translation A-722
(Conclusions and
References)
bn/A

Kovarskii, A.E., Bruter, D.P.,
and Levin, T.I.

Vegetativnaia gibridizatsiia kukuruzy.

[Vegetative hybridization of maize].

In Kishinevskii Sel'skokhoziaistvennyi
Institut imeni M.V. Frunze. Sbornik rabot
po izucheniiu kukuruzy v Moldavii,
pp. 147-176. Moskva, Sovetskaia Nauka.
1956. 59.22 K64

(In Russian)

GENERAL CONCLUSIONS

As a result of experiments in vegetative hybridization of maize conducted during 1949-1951, the following conclusions can be made:

1. The embryo of a maize seed deprived of its endosperm has the capacity to germinate and to display increased lability. Unique metabolism taking place in the first stages of the growth and development of an embryo deprived of its endosperm causes deep changes in the young organism and increases its plasticity.

2. It is possible to obtain most effectively vegetative maize hybrids by the method of transferring an embryo seed of one variety onto the seed endosperm of another variety. In addition, great importance is attached to the appropriate working technics and the creation of conditions conducive to ensuring adequate coalescence of the embryo with a strange endosperm. Otherwise the embryo is apt to take up soil nutrition with the aid of its own radicle and thus to elude the sphere of influence of the strange endosperm onto which it has been grafted. Feeding of grafted shoots by an alien maize endosperm must be prolonged maximally

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by letting them grow in rinsed and calcined sand devoid of nutrient substances and by planting the grafted seed deeper in the soil.

5. Vegetative maize hybrids are capable of producing in their progeny a series of forms with increased vitality surpassing by far the original parent forms in productivity. In individual cases in F_1 the increase in productivity of vegetative maize hybrids comes to 72.6% as compared with the original forms, and to 50% as compared with corresponding sexual hybrids.

4. A study made of vegetative maize hybrids in F_0 and F_1 discloses their great similarity with corresponding sexual hybrids. Nonetheless, there are unique distinguishing features of vegetative hybridization, compared with sexual, which exist by virtue of the fact that hereditary types in vegetative maize hybrids are much richer and much more diverse than in corresponding sexual hybrids.

5. The most important circumstance among the characteristics of vegetative hybrids in F_1 is the definitely established intermittent appearance (in a notable percentage) of new formations possessing retainable heredity and in many cases high vitality and productivity.

6. Vegetative hybridization is a very efficient selection method. In utilizing it, it is possible to create very rapidly (in 2-3 years) new constant families of vegetative maize hybrids which are very valuable for immediate adaptation to production, particularly in obtaining inter-family [mezhsemeinykh] sexual hybrids.

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Translation A-723
(Conclusions and
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Kovarskii, A.E., and Guliaeva, E.M.

Vliianie mentora chuzherodnoi pyl'tsy na samoopylenie kukurusy i ispol'zovanie ego dlia tseli selektsii i gibridizatsii.

[Influence of mentor of alien pollen upon the self-pollination of maize and its use in selection and hybridization]

In Kishinevskii Sel'skokhoziaistvennyi Institut imeni M.V. Frunze. Sbornik rabot po izucheniiu kukurusy v Moldavii, pp. 127-146. Moskva, Sovetskaia Nauka, 1955. 59.22 K64

(In Russian)

CONCLUSIONS

1. In self-pollination of maize, the mentor of alien pollen of various biological species increases sharply the setting of seed on the ear in the year of pollination.

2. Under the influence of alien pollen, depending on its species, there appear specific characteristics in the "mentored" self-pollinated lines of different varieties of maize, which are retained in subsequent generations.

3. The self-pollinated "mentored" lines which had been produced in one year, appearing at staggered intervals, and had been isolated from one variety after crossing between themselves, show the following year a marked increase in vitality, compared to the variety from which they had been isolated.

4. As a result of their crossing among themselves, "mentored" self-pollinated lines with strictly distinct morphological characters, and descendent from different varieties, produced hybrids the large majority of which show increased

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heterosis as compared with conventional intervarietal hybrids and, in many cases, with interlinear ones descendent from the same varieties.

5. In view of the marked increase in vitality under the influence of an alien pollen mentor during self-pollination of maize and, frequently, in view of the retention and formation of greater uniformity in the offspring--with the appearance of new specific characters depending on the mentor species -- this method should be tested most extensively in selection work. In the first instance, investigations should be begun with obligate cross-pollinating plants--winter rye, beets, sunflowers, castor plants, buckwheat, the mustard family and, naturally, maize.

6. The prospects for increased vitality and directed formation of the process in self-pollinated lines of obligate cross-pollinating agricultural plants, with the aid of an alien pollen mentor, should open new and very wide horizons for practical selection.

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Peterburgskii, A. V.

Nekotoryye voprosy korenvogo pitaniia rastenii
(po rabotam laboratorii D. N. Prianishnikova)*

[Some problems of root nutrition of plants (after work done at the laboratory of D. N. Prianishnikov)]

Pochvovedenie, no. 6, pp. 68-77
1954 57.8 P34

(In Russian)

Prianishnikov and agrochemistry

"The life of a scientist is in his work", - wrote K. A. Timiriasev in his sketch on L. Pasteur. This thought characterises in full measure also the life and activity of Timiriasev's most talented student - Dmitrii Nikolaevich Prianishnikov. The basic importance of his works in the development of native agrochemistry is generally known, and their role in the practical use of chemicals in socialist agriculture not only fails to decrease with the years, but, on the contrary, it grows as production of fertilisers and their application expands in our country.

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The unprecedented rate envisaged by the Communist party and the Government for the future development of the fertiliser industry, which has been made responsible for raising the annual output of mineral fertilisers up to 28-30 million tons within the next 10 years, and the directive issued to agriculture concerning a 1.5-2 times increase, as compared with 1953, in stock-piling and

*From a report read at the meeting of the Agrochemical section at the House of Scientists, 4 May 1954, dedicated to the memory of D. N. Prianishnikov.

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placement of local organic fertilizers within the next 2-3 years - raises also the demands made of agrochemistry on the whole to a new level, and thus also the appraisal of Prianishnikov's works in particular.

His whole conscious life, which was long and full of creative work, Dmitrii Nikolaevich devoted "to investigations of agronomic chemistry and plant physiology." While he was still a youth, agronomic chemistry had attracted his "attention because it was linked to the practical tasks of increasing the yields."

It is known that the first half of Prianishnikov's activities proceeded under circumstances that made the realization of his achievements in practice almost completely impossible. This was due to the social and economic conditions of pre-revolutionary Russia. But during the second period of his scientific work Dmitrii Nikolaevich undoubtedly experienced one of the greatest joys given to man, when he saw how widely his most daring dreams and projects were being realized in the Soviet epoch. He departed from us fully convinced that the enterprise which he had served would not die with him.

In this connection, it is pleasant to note that attempts on the part of some, individual colleagues who in late years repeatedly tried to invalidate agrochemistry as a science and to betray the very name of its founder to oblivion proved unsuccessful. As was to be expected, it proved impossible to ignore a science the consequences of which are of positive significance in the intelligent use of one of the most important means for raising productivity and increasing the fertility of soil. It is impossible to erase from natural history the name of its classic who established the scientific school in agrochemistry, who, for decades to come, has ensured the leading importance of Russian, of Soviet, works throughout the world in the sphere of root nutrition of plants and, especially,

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in the study of the most complex problem of nitrogen nutrition of agricultural crops. [Begin p. 66]

The interest shown in the memory of D. N. Prianishnikov and in his scientific legacy is evident from the simultaneous publication of the selected works of the famous scientist by the Academy of Sciences of the USSR and by the Sel'khozgiz [State publishers of agricultural literature]. Of exceptional importance is the new edition of Prianishnikov's fundamental work--"Agrochemistry".

The scientific legacy of Prianishnikov is huge, for he was an unusually versatile scientist who left irradicable traces in many branches of science--in the physiology and biochemistry of plants, agrochemistry, plant culture, and in the technology of fertilizers.

The ideas and experimental works of Dmitrii Nikolaevich must be developed in every aspect in accordance with the new demands of production and the latest methods of research. One must realize the great responsibility that falls upon the shoulders of the students of Dmitrii Nikolaevich who are to continue his work in our time, when the Party and the Government have put before the whole Soviet nation a program calling for a steep rise in agriculture in order to ensure a supply adequate to meet the food demands of the population, and the raw material demands of the food and light industry.

Root nutrition of plants

In the last quarter of a century the theory of the nutrition of higher plants has often been the subject of well-grounded criticism and has undergone substantial modifications in many of its aspects, in the light of new experimental investigations.

If we are to disregard the chronological order and begin with what is most

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important, then we first must indicate that we now have an entirely different concept of the most important process in plants - namely photosynthesis. The hypothesis of Baier which dominated science for many decades, and according to which formaldehyde was the first product of this process, has proved insolvent. In reality, however, formaldehyde cannot be found even in the initial phases of photosynthesis (after 30 seconds) by the most accurate method employing tagged carbon. In its stead there emerge many compounds of an incomparably more complex character. Among them are found malic and pyruvacemic acids, saccharophosphates [sakharofosfaty], glycerophosphoric acid [fosforoglitserinovaia kislota], amino acids and even albumen.

The participation of phosphoric acid in the formation of the first products of photosynthesis is supplemented by the important role of this substance in the energy of plant organisms which finds expression in the reactions of phosphorylation, with the formation of intermediate compounds of high energy levels. Decomposition of these compounds releases energy required for the normal course of metabolism in the organism.

Soviet scientists (Vinogradov, 1954) have shown that oxygen released into external environment during photosynthesis is released not as a result of the decomposition of carbon dioxide, but because of the dissociation of water, with the formation of reducing agents [vosstanovitelei]. Then these reducing agents unite with carbon dioxide and thus form the beginning of different organic products.

Dissociation of water occurs in light; the initial reduction of CO_2, however, occurs in the dark, outside the chloroplast, even though the further conversion of the emerged substances also require the energy of light. Although it was practiced still quite recently, it now is no longer possible to draw

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strict demarcation lines between atmospheric and root nutrition of plants, with the first implying assimilation of carbon by the leaves, and with second--assimilation of nitrogen and ash elements by the roots. Soviet physiologists have fully established a certain importance of the bicarbonate ion, which enters the roots from the soil, in the synthesis of organic substances by the plant (Kurssanov, 1951; Kusin, 1953). On the other hand, the supplementary feeding of plants through the leaves, first investigated in the laboratory of D. N. Prianishnikov, is of practical importance. [Begin p. 67] Roots are no longer considered as mere organs, for the most complex synthetic processes have been discovered in them (Klenk, 1945; Sabinin, 1949).

Wide-spread recognition was accorded D.N. Prianishnikov's theory (1947) on the presence of "a close reciprocal relation between the external conditions of plant nutrition and the internal processes of plant metabolism", formulated on the basis of his half-century long experimental and theoretical works on nitrogen nutrition and on the exchange of nitrogenous substances in plants. This theory is in full accord with the guiding principles of Michurinite biology concerning the unity of organism and environment.

This unity bears all the marks of materialistic dialectics, but it is not invariable, static. It is the unity of contrasts [protivipolozhnostei], at the basis of which lies the struggle of contradiction.

In the process of root nutrition intensive metabolism occurs between plant and soil, during which the plant, as well as the soil, possesses an intensely pronounced absorptive capacity.

If, however, in an agronomic sense, the most important interchange absorptive capacity of the soil is governed by comparatively simple physico-chemical regularities, then the absorptive capacity of the plant is distinguished by a selective

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character which depends on the requirements of the developing organism which changes as time goes on.

At the present time, no one disputes the fact that nutrient substances enter the plant through the roots independently of transpiration.

Nor can osmosis and diffusion serve as the basic mechanism in salt infiltration of the plant, or in the further mobility of salts in the plant tissues and organs. Thanks to the use of tagged atoms, it has been demonstrated that the actual speed of substance entry and movement in plants surpasses the potential rates of diffusion and osmosis by more than a hundred times.

The dissimilar plant absorption of two ions of one electrolyte cannot be explained by an excess intake of cations or anions, for it is impossible to overcome electrostatic forces which exist among counter-charged [protivopolozhno zariazhennymi] ions of salt alone.

A satisfactory explanation of the unusually high speed of substance entry into the plant, as well as of its unequal absorption of separate ions from an external solution can be given only on the authority of the hypothesis concerning adsorption exchange of ions between the root system and the soil. The merit of this hypothesis rests also in its ability to fix the processes of root respiration and root nutrition of plants.

As it dissolves, the carbon dioxide secreted by roots forms carbonic acid the ions of which are, in part, adsorbed by the cell walls and the bordering layer of the protoplasm of root hairs. Consequently, the ions H^+ and HCO_3^- are an inexhaustible source of plant interchange; the plant exchanges them for cations and anions respectively at an equivalent rate. (Unfortunately, the anion absorption capacity of the root system has scarcely been investigated.)

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In areas where the root hairs come in very close contact with soil colloidal particles, there forms a film of the solution saturated by carbonic acid. The latter not only displaces the ions absorbed by the soil in interchange, but, in part, it also dissolves mineral compounds of low motility. Both processes lead to the plant's mobilization of its own food elements under soil conditions.

Apart from the higher plants, carbonic acid gas is secreted into the soil also by a large number of microorganisms. However, neither early nor modern investigations leave any doubt as to the leading role of the plant. In the absence of plants, the amount of carbon dioxide escaping from the soil is always many times smaller. [Begin p. 68]

The amount of carbon dioxide given off by plants through the roots during vegetation is likely to exceed the weight of the root system by several times (Kossovich, 1906).

Apart from carbonic acid, there are found in the root excretions of plants a series of organic acids and other substances the total amount of which, as it is known to be in sterile crops from experiments, may reach several percent of the weight of a plant-synthesized mass (Demidenko, 1928; Mashkov, 1949). These substances are also a means of plant influence upon external environment, but they obviously are utilized primarily by microorganisms of the rhizosphere as food.

The possibility of a simultaneous adsorptive absorption of cations and anions by the active part of the root system - its root hairs - is determined by the presence of both a positive and a negative charge on the different sections of the demarcation layer of protoplasm. Here the ampholytoid properties of albumin are pronounced. The amino acids of which it is composed have isoelectric points at various pH (from 3 to 10.8). This makes the preponderant dissociation of anions by certain amino acids (at pH below the isoelectric point),

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and of cations by others (at pH above the isoelectric point) entirely probable. Accordingly, an exchange of anions will occur in the first case, and of cations - in the second.

Each albumin molecule has about 100 mineral ions in its composition; among them are prevalent cations (which, in turn, denotes a preponderance of negatively charged albumin components).

The adsorptive character of the entry of ions into plants has been corroborated in a series of interesting investigations conducted by I.I. Kolosov (1953), E.I. Ratner (1950) and a number of other Soviet scientists, including my own experiments (1950).

The further mobility of ions in the protoplasm is due, first, to its circular motion which entails continuous reciprocal action between its external surface and the internal surface of the cell membrane. In the second place, there is no doubt that an ion exchange is taking place between albumin molecules. Their decomposition and synthesis occur continually. According to data on experiments conducted with tagged nitrogen the duration of the existance of individual albumin molecules in plants is calculated in only a few hours (Kursanov, 1954).

An investigation of cation capacity in the roots of various agricultural crops produced the following results (in milli-equivalents per 100 gr of dry substance): in cereals 9--22; in tomatoes and potatoes 34-38; in legumes 40-59.

Absorption capacity reaches its highest magnitude in the tip of the growing root, i.e. there, where the root hairs emerge under soil conditions. The fact that the maximal magnitude of the negative electric charge is adapted to the same zone of the root merits attention. It is curious that the artificial increase in the negative charge of the roots is accompanied by their increased

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absorption of cations from external environment. This demonstrates a relationship between plant nutrition and phenomena of the electrical charge.

The share of hydrogen ions (in percentages of the entire cation absorption capacity in roots) in cereals is from 11 to 64 (in investigation of plants developing on salt solutions).

Plant assimilation of ions adsorbed by the soil

From the works of K.K. Gedroits (1935) and other Soviet agrochemists it ensues that in every type of cultivated soil there are hundreds of times more cations in the exchangeable state (available to plants) than in the soil solution. Cations from soluble mineral fertilizers introduced into the soil are distributed in it in approximately the same manner. This, however, denotes that under natural conditions the nutrition of cultural plants, K, Ca, Mg, NH_4, [Begin p. 69] depends to a high degree on the conditions of their conversion into a solution.

This conversion can be realized independently of plant energy (exchange reactions, thanks to the presence of soluble electrolytes, including products of microbiological processes) as well as in association with plant activity.

Until recent times, it was taken for granted in agrochemistry and in plant physiology that the plant itself was incapable of displacing cations from the soil into a solution, and that it wholly depended for its food on the reciprocal reactions occurring in the external environment beside it. By now, there is an accumulation of sufficient experimental data indicating that the role of the plant itself is very important in this process. I shall cite some data of my own experiments.

In the first variation the soil suspension came in contact with the roots;

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in the second variation the suspension was isolated from the roots by a membrane from celloidion, parchment or cellophane which precluded contact of the root system with the hard particles bearing on their surface adsorptive potassium, but left a possibility for the penetration of root excretions into the suspension through the membrane, as well as of potassium salts from the suspension to the roots; finally, in the third variation, the roots did not enter into any reciprocal action with the suspension whatsoever, and were able to absorb only the amount of potassium which was converted into a solution as a result of hydrolysis of the adsorbent or of the soil (to plant containers only hydrolysate was added).

In experiments with various crops: barley, oats, wheat, buckwheat, lupine, peas, sunflowers and garden peppergrass it was established that they assimilated the most potassium in the first experimental variation, very little in the second, and usually not at all in the third. This, however, denotes that adsorbent hydrolysis is unimportant as a factor in the conversion of adsorptive cations into a solution. Root excretions of plants are the basic factor in releasing exchange potassium of the soil. These excretions, however, exert the strongest influence upon the soil or another adsorbent only at a direct contact of the root system with a solid phase containing exchangeable potassium. Thus, for instance, in one of the experiments with sunflower sheets, they had assimilated potassium (in mg per 24 hours) from assanite [ashanitovoi] clay saturated by it: a) in direct contact of roots with clay suspension 5.96; b) when clay suspension was isolated from roots by a membrane from celloidin 1.88, and c) in adding to the roots hydrolysate of a clay suspension which had been in no reciprocal action with the roots, 0.84.

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What is the mechanism of plant assimilation of cations adsorbed by the soil? There are three possible ways of releasing cations adsorbed by the soil and of their absorption by roots: A - a direct exchange by ions of one charge between the micelle (colloidal particle of soil) and the surface of root hairs - "a crossing over" - is, probably, an unlikely case; B - displacement of cations from the soil by carbonic acid exhaled by the root system, with a further osmotic entry of soluble salt into the plant; these processes, undoubtedly, are of importance (although not of fundamental) in the nutrition of agricultural crops; C - ionic interchange between soil solution and the surface of root hairs, on the one side, and between soil solution and soil colloids, on the other side.

I attribute the third process a decisive role in root nutrition of plants by means of interchange absorption of ions by the soil. In this process adsorptive absorption is accomplished by the reciprocal action of soil and plant not directly "crossing over", but through the solution which, in the form of a film, constantly surrounds the soil particle, as well as the root hairs in an active state. Ion exchange past the liquid phase cannot as yet be considered as strictly conclusive.

Attempts to study plant nutrition from dry soil have proved unsuccessful, even [Begin p. 78] though it was noted that cultural plants are able to absorb nutritive substances from a solution of a very high concentration (at osmotic pressure of about 15 atm.). From such a solution the roots practically absorb no water. By such a nutritive method, however, growth of crops is possible only in the event the other half of the root system is submerged in water and, consequently, absorbs it quite independently of salts (D. Fedorovskii, 1951).

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Similar conditions may be found also under industrial circumstances, if the soil has saline horizons which, however, are rich in nutrients.

Along with cations the soil, on the basis of interchange [chemo], absorbs also anions. This aspect has not as yet received sufficient study, although it has definitely been demonstrated as regards the phosphate anion which is adsorbed by Kaolinite [kaolinit], montmorillonite and by all more important types of soils: red soils, sod-podzolic and black soils (Mashtakov, 1951 and others). Furthermore, phosphate-ion interchange absorption by red soil is rejected (Gorshkol'skii, 1954). For phosphates, however, their chemical absorption by the soil is also very pronounced. Exchange adsorption of the sulfuric acid anion by bentonite (Kitchen, 1950), and the microbiological nitrate absorption by the black soil (Stark, 1924) have also been noted; data on clay adsorption of the chloride anion is also found in literature (Schofield, 1950). There is no basis to assume that the mechanism in plant assimilation of soil adsorbed anions is in principle distinct from the mechanism of cation assimilation. I succeeded in demonstrating this by growing wheat, oats, sugar beets and tomatoes in an environment practically devoid of salts in a soluble state, since all ions were introduced in adsorbed form.

Under soil conditions, the adsorbents saturated with the ions served as a source of food for oats and clover and they were no worse than mineral salts. Thus, for instance, in one experiment with oats on the cultivated sod-podzolized soil on the "Pekhi" collhoz in the Moscow Region a comparison of a nitrogen-phosphorus-potassium fertilizer in the form of salts and in a state of solid-phase adsorption produced the following results:

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Experimental variation	No fertiliser	NPK in form of salts	NPK in adsorbed state
Yield in gr per container:			
grain.....	13.1	20.96	20.98
straw.....	16.6	29.4	30.4
Grain content in mg of:			
N.....	280.6	475.9	479.8
P_2O_5.....	133.4	201.2	206.8
Ca.....	31.1	42.7	50.8
Weight of air-dried roots in gr.	8.9	4.8	8.9
pH of soil.....	5.0-5.8	5.8-5.9	6.4-6.8

Infection of the sand with rhizosperic microorganisms failed to influence adsorbent ion available to oats. Hence one can draw the general conclusion that the plant itself is entirely capable of converting ions adsorbed by environment [crude] into a solution and of assimilating them.

Acidity of soil and growth of agricultural crops

Of other works on plant nutrition problems which merit mention, I shall dwell briefly only on the following: 1) influence of soil acidity upon plants and microorganisms, 2) micro-fertilisers, 3) importance of microorganisms in plant nutrition. [Begin p. 71]

Not long ago, an opinion was expressed to the effect that acid reaction of soil itself was not harmful to plants (Ignatko, 1954), that the ones who suffer from it are merely the soil microbes which prepare the food for plants. It is

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impossible to agree with this opinion. As early as in 1928-1929, in the laboratory of Prianishnikov, I was able to establish for the first time that the relationship of plants to soil acidity is determined not only by the magnitude of acidity but by other soil properties as well - by its absorptive capacity, buffer action, calcium and aluminum mobility. The higher the content of mobile calcium, the more resistant is the plant to the unfavorable pH indicator. The content of mobile aluminum exerts its influence in a reverse manner [obratnym obrazom]. It was then that I discovered that the behavior of nitrifying bacteria toward soil acidity was approximately the same. Further P.V. Turabin demonstrated that in acid soil manganese can be even more detrimental to plants than aluminum.

Plant suffering during the pH interval unfavorable to its development is determined by many factors. For example, in extremely acid environment nutrition is made difficult by calcium and magnesium, yet in mildly alkaline - by the conversion of iron compounds and other microelements into an unavailable form. Such plant behavior is observed even in water and sand culture media [Kul'turakh] in which all nutritive salts are given in a form ready for plant assimilation. I have observed that a mildly alkaline reaction is more difficult for plants to survive than an acid one. At the same time, it is generally known (experiments were conducted under soil conditions) that the mildly alkaline interval pH is incomparably better for the activity of most bacteria than the acid one. Consequently, the matter does not rest with bacteria.

In the life of plants, the outstanding role of mineral substances contained in paltry amounts, and hence called microelements, has been demonstrated. Fertilizers containing some microelements are even now a serious factor in

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increasing yields under unusual soil conditions. Most frequently a shortage of copper is observed on peat-bog, and of boron - in cases of alkaline soil reaction.

Investigations concerning the role of microelements in the life of plants were first begun back in 1950-1951 by Prianishnikov's fellow workers (Sukho, Belousov).

Microbiological processes of the soil and nutrition of plants

In recent years, the concept, long since developed by V.R. Vil'iams, of the presence of mycorhiza on the roots of many annual field crops has received more wide-spread confirmation, although the role of mycorhiza in the nutrition of higher plants remains as vague as heretofore.

There is increased interest in plant nutrition by means of organic compounds which enter through the roots especially in connection with so-called excretions of rhizospheric microorganisms.

Systematic investigation by Soviet microbiologists (N.A. Krasil'nikova, 1953, and others) have led to the conclusion that under particularly favorable conditions, for instance on Central Asian artificially irrigated [Sul'turno-polivnye] gray soils, the combined mass of these microorganisms can reach 5-7 tons in the arable layer of 1 hectare. This mass of microbes, according to data of the same investigator, is capable of regeneration [mozhet vosobnovlyat'sia] 2--3 times per month.

Naturally, these figures cannot be applied to all types of soils. Nonetheless, it is a completely natural hypothesis that, concomitantly with the positive role that this huge mass of microorganisms performs in the mineral-

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ization of organic soil substances, root remains, and organic fertilizers, by discharging mineral compounds essential to plants, it exerts also a positive influence upon the nutrition of agricultural crops. The latter is possible thanks to progressive fixation of microbial bodies from mineral salts released earlier, as well as from mineral fertilizers introduced into soil, into a form accessible to plants. This problem required further study. [Begin p. 72] Unfortunately, experimentally well established facts which evidence that green plants are definitely capable of mineral development and maturing if they are provided with the required amount of soluble salts, are frequently contradicted by experiments, but more often by hypotheses, declaring that even mineral compounds introduced into the soil in the form of fertilizers ready for immediate plant assimilation, are assimilated by agricultural crops only in the form of microbe excretions, and not otherwise. They fail to determine what sort of excretion it is.

At times similar statements are made by colleagues who, themselves, as far as I know, have not published a single investigation of plant nutrition. In this regard, the article by V.A. Pantsenkov is most characteristic ("Sov. agronomiya" [Soviet agronomy], no. 8, 1953).

It requires no proof that similar opinions lacking any basis are of very little use to science and production. N.G. Chernyshevskiy wrote that in matters of science it is wrong to depend on opinions, even if they are voiced by eminent scientific authorities.

I cannot help citing one more peculiar case. Recently I had to appear in Kiev at a conference dealing with fertilizer problems. Among other reports, there were some devoted to foliar nutrition of plants. I referred to my

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experiments which demonstrated that tagged phosphorus applied to leaf upper leaves reaches rather quickly the different plant organs all the way down to the roots. They authors have demonstrated that it takes only a few minutes for this phosphorus to get from the external solution through the roots into the surface organs. In either of the two cases the phosphorus compounds, naturally, could not turn into microbe excretions in so short a time. Nevertheless, one of the conferees--Dr. of the Agricultural Sciences, V.G. Alekseyev - declared that, in his opinion, the tagged phosphorus which had entered the plant through the leaves proceeds unchanged to the roots, is expelled by the latter into the soil, there consumed by microorganisms, and is assimilated by plants only in the form of microbe excretions.

Such are the recumbent way upon which root nutrition was made to travel to please a fixed idea!

Either D.N. Prianishnikov nor other Soviet agrochemists have ever denied, or could have denied, the role of biological processes in the soil, in the mineralization of organic compounds. In this regard, ammonification and nitrification, the activity of phosphorbacteria, sulfur bacteria, iron bacteria and other microorganisms are of prime importance in the preparation of plant nutrition. Furthermore, excretions, the products of the activity of the microorganism groups listed, are in the end result mineral substances.

Where, then, is the logic in asserting that these same mineral substances made available to plants also independently of bacterial activity, are inaccessible and inassimilable unless they pass through the body of microbes?

The presence of a huge amount of microorganisms near the roots, feeding on

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the substances of dying root hairs and on root excretions, accepted the hypothesis on the presence of a powerful multilayer living barrier on the root surface. This biologically active barrier, as the Corresponding Member of the Academy of Sciences, USSR, N.A. Krasil'nikov asserts (1951), alters "all nutritive elements in the soil and all root excretions." Therefore "nutritive substances enter the root system, and thence the surface parts of plants, in a form other than the one they are in in the soil."

In what kind of form - this N.A. Krasil'nikov fails to explain, even though his whole concept is very vague without such an explanation.

Disregarding the fact that it is hard to agree with the assertion that a direct reciprocal action between plant and soil is totally absent [Begin p. 75] (if the barrier indicated had really existed), then the presence of this barrier should be doubted also because of other considerations. It should be noted that in case microorganisms were to change everything and to render everything indistinguishable, then fertilizer forms would be of no practical importance in the metabolism of plant organisms.

Meanwhile, there is not the slightest doubt that, for instance, nitrate and ammonia nitrogen introduced in soil in the form of fertilizers exerts far-reaching influence (varying in accordance with the form of fertilizer) upon plant metabolism and upon the level and quality of yield. This was first most convincingly demonstrated by D.N. Prianishnikov many decades ago and was later developed in the works of many of his students and followers not only in our country, but also beyond its borders.

Furthermore, does not the physiological acidity of ammonia salts and the physiological alkalinity of saltpeter furnish completely convincing evidence of

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the preponderance of cation entry into the plant in the first case, and of anion in the second, regardless of the presence of rhizospheric microorganisms? What then are the results of its influence which is so much discussed by the adherents of the "biological barrier"? Or should potassium be used, even though it fails to form stable bonds with organic compounds either in microbe bodies, or in plants, and practically exists in both cases in ionic form? In what compound form excreted by microorganisms, other than potassium ions, can it enter the plant?

Plant nutrition with mineral salts has been demonstrated in experiments under complete absence of microorganisms. Plant assimilation of ammonium nitrogen in sterile culture media was first demonstrated by P.S. Kossovich at the end of the past century. Later I.S. Shulov (1913) was successfully growing plants on solely a mineral salt diet and under strictly sterile conditions.

Now, some authors (for instance, Doroshenkii, 1951) treat the results of I.S. Shulov's experiments as if higher plants were capable of sustaining themselves in water media even in the absence of microorganisms, but that they are deprived of this capacity under soil conditions, since their roots are constantly surrounded by microflora. We, nonetheless, are interested also in the aspect of the principle of the problem: if, in the process of long evolution, higher plants have developed a capacity to assimilate mineral salts through the roots without the assistance of lower organisms and have retained this capacity up to now, then it is foolish to admit that they will not use this opportunity daily and hourly under any condition of their habitat.

Adherents of the hypothesis that cultivated plants feed exclusively on

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microbe excretions, denying in essence the role of mineral salts, assume silently that root nutrition is realized actually at the expense of some sort of organic compounds. In this connection, one should recall the more accurate of the experiments conducted up to now in the nutrition of higher plants with organic substances. G.G. Petrov published back in 1911-1913 a paper stating he had succeeded in demonstrating in sterile cultures that maize shoots assimilated asparagine nitrogen, a series of amino acids and even peptone, although in a much lesser degree than saltpeter nitrogen. I.S. Shulov was working during the same period; thanks to improved technics of sterile cultures, he grew maize and peas for a longer period of time than did G.G. Petrov. I.S. Shulov confirmed the assimilation of asparagine nitrogen by these plants, but lecithin phosphorus had proved completely unavailable to them. In containers which had failed to retain sterility, lecithin, on the contrary, had proved a good source of phosphorus.

L Later experiments conducted by Ghosh and Burris (1950) with sterile cultures of clover, tomato and tobacco shoots in utilizing tagged nitrogen(N^{15}) showed that the first two plants can, in part, assimilate nitrogen from amino acids, [Begin p. 74], but that the third one lacks this capacity. After tracing the order of nitrogen consumption by shoots from various sources, these authors arrived at the conclusion that they first utilize reserve seed substances, then the added ammonium salts, and only in the last instance the amino acids added in part.

N.A. Krasil'nikov demonstrated that a series of such complex organic substances as intibiotics had entered the plant through the roots and migrated

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to the surface parts (including leaves). This fact in itself is very interesting. However, the mobility of the substances indicated remained unchanged within the plants, obviously it had been possible only because they had not been involved in the synthetic process. Experiments conducted by T.T. Denisenko in feeding maize with glucose led to infection of the plant (personal report, 1953).

There are indications of the importance of the growth substances and vitamins excreted by microorganisms for plants. E.G. Eholodnyi has discovered some sort of volatile microbe excretions which exert a beneficial influence upon root growth. Unfortunately, they have not as yet been investigated more thoroughly.

Hence, it would be erroneous to deny the role of certain organic compounds in root nutrition of higher plants. Part of these substances may be excretion products of rhizospheric microflora. It would, however, be altogether wrong to ignore mineral salts as the basis and main source of root nutrition of all agricultural crops. The idea that rhizosphere microflora is of sole positive importance in plant nutrition should be recognized as equally objectionable. It should be remembered that at the time F. Engels criticized the limitations and one-sidedness in the "struggle for existence" in Darwin's theory, he noted that "the reciprocal action of living beings includes conscious and unconscious cooperation, as well as a conscious and unconscious struggle" (Engels, F., Dialectics in nature, 1950, p. 249).

To see no more than cooperation in the reciprocal relations of higher plants and rhizospheric microflora is tantamount to distortion of their real relations. Even if microbes parasitic on higher plants and, particularly, on their root system were discovered, an admission of a positive usefulness of even non-

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parasites is, naturally, a gross exaggeration. Interspecific reciprocal relations are very complicated. To have at our disposal a sufficient number of facts justifying our assertion that a unique struggle for mineral salts frequently takes place between higher plants and rhizosphere microorganisms. The biological absorption of saltpeter and the salts of phosphoric acid by microbes, in the absence of higher plants (and even in their presence) leads to unavailability of this nitrogen and phosphorus to agricultural crops for a more or less extended period.

The last data on experiments with protozoa and bacteria tagged with phosphorus (p^{32}) evidence that they lose only an insignificant part of the phosphorus absorbed (3.5% of the original) even in the fourth generation. Agrochemistry knows of many phenomena of real starvation of higher plants due to microorganic fixation of their mineral food elements. This manifests itself graphically when fresh organic substances rich in cellulose, but poor in nitrogen are introduced into the soil. This created conditions for energy fixation of soluble soil nitrogen by cellulose decomposing bacteria. As a result, nitrogen starvation sets in for higher plants. Therefore, it is rightly recommended that time, technics of fertilizer placement, and combination of types be arranged so as to make nutritive substances more available to plants and less to microbes. [Begin p. 75]

For the purpose of decreasing microbe fixation of mineral salts essential to plants, V.R. Williams recommended that organic and mineral fertilizers be applied simultaneously, assuming that organic substances would serve as a source of food and energy for the microorganisms, and, due to this, mineral salts would be more fully assimilated by the plants.

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D.N. Prianishnikov emphasized the role of the organic substances of manure in the improvement of the physical properties of soil, in raising their absorptive capacity and buffer action which create a more favorable background for the action of mineral fertilizers. Apart from this, he wrote, that application of manure exerts an influence also on the microbiological activity in soil and increases the supply of carbonic acid for plants. Prianishnikov emphasized that maximal yields "are achieved by the combination of manure and mineral fertilizers which amply supplies plants with assimilable food in the first stages of their development and simultaneously produces a reserve of nutritive substances in the form of manure which gradually become active..." (Agrokhimiia, 1962, p. 563; the preceding references are on p. 519 and 570). Perhaps Prianishnikov had precisely this in mind when he wrote that "no matter how great the production of mineral fertilizers in the country, manure will never lose its importance as one of the principal fertilizers in agriculture" (same journal, p. 54).

The plant itself is historically adapted to a struggle, and not only to cohabitation with microorganisms. It is enough to recall the bactericidal properties of plant juice demonstrated by Soviet microbiologists (Mishustin, 1954; Ivanova, 1951; Voroneva, 1950; Afanas'eva, 1950).

There is an accumulation of facts which indicate the capacity of higher plants to exude very active ferments through the roots onto the external environment. It is possible that such is the course of the processes which decompose organic substances and release elements of mineral nutrition (Kogrevich, 1949). Does this not indicate that the dependency of higher plants on microbe excretions is not so absolute and not so complete as visualized by the person who is demonstrating that without microbes our crops do not assimilate even the ready

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salts from mineral fertilizers?

Yet, not only the entry of substances into a plant through the roots, but their exudation by the roots as well fail to deprive them of their characteristics by a so-called biological barrier. Dementevich, Shestakov and Polosin have demonstrated long since (1927), by utilizing an original method in the laboratory of D.N. Prianishnikov, that, with the decomposition of phosphorite, lupine renders so many phosphates available to plants that it can provide not only itself with phosphorus, but can supply phosphorus nutrients also to oats and millet which do not possess the capacity to exert an active influence upon phosphorite. [Later on, Sokolov (1935) demonstrated with P^{32} that legumes actually assimilate phosphates which they had assimilated from $Ca_3(PO_4)_2$]. If, however, lupine were deprived of direct contact with phosphorite particles then, as was first established by F.N. Kossovich at the beginning of the twentieth century, it also begins to resemble oats and millet in regard to assimilation. Consequently, the matter here, too, rests with the plant and not solely with microbes. For the qualitative composition of rhizosphere microorganisms, although distinct, is not so varied in the different crops within the limits of one soil type (Zhukovskaia, Topper, 1948).

Conclusion

In recent years Soviet physiologists, agrochemists and microbiologists have attained considerable success in developing the plant food theory. A radical change has taken place in the concept concerning the most important process in green plants - photosynthesis. It has been demonstrated that, in part, carbonic acid can be assimilated through the roots, and nitrogen and ash substances - through the leaves. The important role of microelement nutri-

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tion and of so-called growth stimulants in the developments of plants has been established.

[Begin p. 78] Chemical methods of weed control have been worked out. Bacteria have been discovered which decompose silicates in the soil thus releasing potassium, and which dissolve tri-calcium phosphate thus converting it into a form more available to plants. The hypothesis concerning adsorption entry of ions into the root system has been proved.

It is, nevertheless, impossible to agree with the opinions of a number of scientists concerning the incapacity of agricultural crops, to assimilate even those salts introduced in the form of mineral fertilizers quite ready for plant nutrition unless they are assisted by rhizospheric microorganisms. This opinion is wholly refuted by old and by new investigations in the realm of root nutrition and plant metabolism. The activity of the plant itself must not be belittled in the feeding process. Microbe absorption of soluble salts and their conversion into organic substances of the microbe body eliminates the possibility of plant assimilation of the appropriate elements of their nutrition for a long time.

If we were to recognize, in principle, the truth of V.R. Vil'iams hypothesis "to feed the plant, but not to fertilize the soil", then fertilizer is, so much the more, applied for the purpose of feeding higher plants, and not microbes.

The role of microorganisms is very important in the mineralization of root and harvest remains and of plowed under organic fertilizers - this fact has long since been established and recognized by all agrochemists. Mineralization

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leads to the formation of salts available to higher plants. Yet, on the other hand, we must in every way strive to safeguard the plant from microbe competition for the possession of soluble salts; in this respect, much can be achieved with techniques for fertilizer placement.

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Translation A-726
(In full)
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Mardzhanian, G. M., and Ustian, A. K.

Fosfororganicheskie preparaty vnutrirastitel'nogo insektitsidnogo deistviia i problema bor'by s sosushchimi vrediteliami na khlopchatnike.

[Organic phosphorus preparations of intra-plant insecticidal action and problem of controlling sucking pests on cotton]

Akad. Nauk Armianskoi SSR. Izv. Biol. i Sel'sk. Nauk. vol. 8, no. 10, pp. 139-150, Oct. 1955. 20 Eng.

(In Russian)

Successes which were achieved in the last decade in the field of chemical means for the control of harmful insects, made it possible to raise anew and to solve many difficult problems for the protection of plants.

Creation of new insecticides from the group of chlorinated hydrocarbons considerably lifted the role of the chemical method on the general front of fight for higher yields.

The use of DDT and of hexachloran in the Armenian SSR solved, in a positive manner, the problem of control of Italian locust, of racemose leaf-roller (Lepidoptera, Tortricidae), of alfalfa weevil (Phytonomus), lesser apple worm (Anthonomus pomorum L.), of a group of cutworm moths (Noctuidae), of pests of vegetable and melon crops (cabbage butterfly, flea beetles, cabbage moth [Plutella maculipennis Curt.]), pests of forest plantings (pine saw flies [Sirex], oak borer [Curculionidae])

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brown-tail moth (Hygmia phaeorrhoea Don)), and many other forms of harmful insects. The use of DDT also solves the problem of control of the basic chewing insects of cotton (cutworm moths: Laphygma exigua, and Chlorides obsoleta F., and others).

Preparations from the group of chlorinated hydrocarbons have played and are playing now a progressive role in the control of harmful insects also in other republics of the Soviet Union and in foreign countries.

According to data of P.G. Kharles [2] although the population in U.S.A. grew during the period of 1920 to 1950, and the planted area almost did not change, yet the overall volume of foodstuff production increased; this can be explained by a considerable development in agrotechnics, especially by intensification of the control of agricultural pests, which aided in the increase of yields.

According to data of the same author, the wide use of DDT against insects, vectors of infectious diseases, during the period of 1942-1951 prevented in U.S.A. 100 mln cases of malaria, typhoid and dysentery, and saved 5 mln of human lives.

Undoubtedly, the preparations of chlorinated hydrocarbons will as yet remain in the arsenal of remedies for the control of harmful insects.

However, the cited preparations, having sharply improved the work of control of gnawing insects, could not also settle the problem of control of the sucking pests. Moreover, the wide and intensive use of DDT, of hexachloran and of other chlorinated hydrocarbons often brought about a mass increase of pests of the sucking group (Acaridoidea,

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Aphididae, and others). Thus, for instance, the wide and repeated use of DDT (Begin p. 140) sharply increased the numbers of Tetranychus urticae Koch and of Doralis frangulae Kalt. on cotton, of Acaridoidae on fruit trees, and so on.

Thus, a series of pests which, before the use of these insecticides, had only a secondary and subordinate significance, after their wide and intensive utilization became exceptionally harmful.

It is interesting to note, that with intensive utilization of DDT such universally recognized acaricides, as ground sulfur and polysulfide of calcium, could not in a sufficient degree hold back the inrush of mass development of Tetranychus urticae Koch, when these acaricides were used together with DDT, additional, repeated applications of the acaricides were required.

In order to demonstrate the above cited situation, we think that it is necessary to give results of one of the many experiments conducted by us for this purpose.

The experiment was started in 1954 with variety 12-98 cotton, for the control of pests which damage the fruit-elements.

The first dusting of cotton was done on June 25, the second--July 5, the third--August 21 and the fourth--August 31. In all variants of the experiment DDT was used together with ground sulfur in a ratio 1:1. The norm of output of the 5.5% DDT dust comprised during the first dusting 20 kg per h, during the second dusting 25 kg and during the third and fourth application 30 kg per h. Arsenate of calcium was also taken for

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comparison. Taking stock and evaluation of the infestation of cotton by Tetranychus urticae Koch. was done by a 5-point system. Cotton leaves, the surface of which was (up to 10%) covered by colonies of mites and by brown spots were given a Point 1 marking. Point 2 was given when the infestation reached 25%, point 3--up to 50% and 4 when the surface was covered to 75 and more per cent. The mean infestation was developed by formula $X = \frac{a-b-c}{p} \times \frac{100}{75}$, where a-b-c is the sum of frequencies of the points; p - the total amount of counted leaves, and 75 - the highest point of infestation.

The scheme of this experiment and the results of calculations are given in table 1.

As seen from data in table 1, the increase of mites developed most intensively on sections which were dusted with DDT; next, once with arsenate of calcium, 3 times with DDT; and, finally, had 4 applications of calcium arsenate. This conclusion is evident both from data of infestation of leaves by mites, as well as by the amount of leaves which were retained on the plant. One should note, that falling off of leaves started at the end of August on sections which were dusted with DDT and changed to mass falling off at the end of September.

A sharp difference in infestation and in the number of leaves between separate variants begins from the second half of August; prior to that time the degree of infestation and the number of leaves on all variants of the experiment were almost identical.

One should also note, that with the use of DDT in its pure form, without sulfur, the increase in numbers of mites proceeds much stronger.

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In this case (the sentence continues on page 141, after table 1)

Begin p. 141

Table 1

Infestation of cotton by Tetranychus urticae Koch.

during dusting with DDT powder.

Variants of experiments	July 12		July 23		August 26		September 30	
	Number of leaves of one bush	% of infestation	Number of leaves of one bush	% of infestation	Number of leaves of one bush	% of infestation	Number of leaves of one bush	% of infestation
Control	14.1	0.86	19.3	1.2	45.2	12.1	52.0	30.8
First application by calcium arsenate, following 3 by DDT	15.5	0.17	19.8	1.0	32.6	25.4	25.2	71
First two by arsenate, following 2 by DDT	16.4	0.4	17.8	0.5	37.5	14.2	24.1	58
All four times by arsenate	17.9	2.5	18.9	0.8	39.4	12.8	24.3	34.6
All four times by DDT	15.9	0.4	18.3	0.6	31.4	26.9	17.7	64.3

starting with the end of August it produced a mass falling off of leaves, buds, flowers and young bolls.

To explain the causes, which give rise to mass increase of Tetranychus urticae Koch. (and other sucking pests), a hypothesis was offered according to which DDT and other chlorinated hydrocarbons, having a powerfully expressed residual action towards the natural enemies (predators

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and parasites) of these insects, are the cause of their mass destruction; as a result of this the natural zoocenosis is disrupted and the controlling action of the predators and parasites is removed, which otherwise would have checked the mass development of sucking pests. Still in 1946, in experiments with aphids, we noted the destructive influence of DDT on predators [6], which, in our opinion, produced the increase in numbers of aphids on tobacco and cabbage, when these were dusted with DDT for the control of aphids, although at the beginning there was a definite percentage in deadlines to tobacco and the cabbage aphids.

I.I. Evstropov [8], F.M. Uspenskii [10], and many others came to the same conclusion. According to R.N. Anaian [1], DDT and GKhTsG, which were used as dusts and in mineral-oily emulsions on cotton, increase sharply the destructive growth of mites, because they are highly toxic to the predators of mites. A slight toxicity of DDT and of GKhTsG to the Tetranychus urticae Koch. does not prevent their growth on cotton, because of a more powerful effect on the useful activity of the predators. This situation was confirmed by many experimental data of Soviet and foreign researchers.

But the newest researches into the causes bring out new facets of this phenomenon; they are clarifying the mass increase in numbers of mites (and other sucking pests). It appears that DDT and other chlorinated hydrocarbons, being physiologically active substances, can directly affect the plants, change the process of nutrition, as a result of which more favorable conditions are created for the increase of sucking pests.

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Klosfermeyer and Rasanssen [6], while studying soil insecticides, have noticed that DDT, hexachloran, lindane, aldrin, and chlorindane, when introduced into the soil in high norms, stimulate the mass increase in numbers of Tetranychus bimaculatus on beans and potatoes. With a norm of application of 119 pounds and over of DDT per acre, potato plants perished altogether from a mass increase in numbers of mites, whereas on the neighboring section, where DDT was not introduced, the plants developed quite normally and were not infested by mites. They explain this by the fact that DDT and other chlorinated hydrocarbons, when introduced into the soil, influence the nutritive process of plants, shifting the biochemical processes into a position which is favorable to the mass increase in numbers of mites.

V.A. Mogalov [7], studying the influence of conditions of plant feeding on the propagation of stinging-sucking pests, comes to conclusion, that the initial and deciding moment of the heightened propagation of stinging-sucking pests appears to be the state of metabolism in the damaged plants. The fact of mass propagation itself of the stinging-sucking pests (aphids, scale insects, mites, and so on) should be seen as an indicator of an increased amount of products of hydrolysis in the plants' tissues. By removing the causes which heighten the hydrolitic processes in plants, it is possible, having made worse the feeding conditions for the pests, to lower their fertility many times.

Rodrignex [9] by means of regulating the phosphorus feeding of tomatoes, and later of beans, established a correlative link between the amount of phosphorus in leaves and the intensiveness of multipli-

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cation of Tetranychus bimaculatus. With the aid of tagged atoms, making use of radio-active phosphorus, he succeeded to establish, that phosphorus is utilized mostly by females during the period of egg-laying, and with an increase of phosphorus in the leaves the number of eggs laid is also increased.

In this way more facts became accumulated, which testify that the cause for the mass increase in numbers of sucking pests, during intensive use of DDT (and of other chlorinated hydrocarbons) can become not only a disruption in the natural balance of harmless and of harmful insects, but also in the change of the feeding process. This conclusion is confirmed also by an increase of the absolute number of predators on plants, which are infested by mites as a result of repeated use of DDT; this was often observed by us on cotton.

Thus, with any explanation of this phenomenon, an undisputed fact remains, that a wide and repeated use of chlorinated hydrocarbons brings about a mass propagation of herbivorous mites and of other stinging-sucking pests; and this is what made it necessary to search for active means of control of this group of pests. Of late many chemical compounds (chlorinated hydrocarbons, sulfuric acid esters, organic phosphates and others) were synthesized and studied.

From among numerous compounds, which underwent toxicological researches, organic phosphates are isolated at present time, (Begin p. 145) many of which produce both the insecticidal and the acaricidal action.

For the control of sucking pests especially valuable are the preparations of intra-plant insecticidal action, or as they are sometimes called

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systemic insecticides.

Insecticides which have a truly intra-plant action, when introduced into the soil or applied to any of the plant's part, enter into the plant and are carried into all of its parts. The treated plant can remain toxic to the insects for quite a long while.

The mechanism of the activity of organic phosphorus preparations of the intra-plant insecticidal action according to modern opinion [4] can be presented in the following manner.

Entering into the plants, these compounds produce molecular complexes with the ferments. After sucking by insects of the plant's juice, which also contains the molecular complexes, the converted phosphoric acid is transferred to the vitally important ferments of the insect (or a mite), and is attached to the place which is normally occupied by the unconverted phosphorus, thus producing a specific toxic effect.

This type of insecticidal action, in our opinion, presents the greatest interest for the control of aphids and mites on cotton at the present phase of development of entomotoxicology.

Beginning with the year 1953, we conducted researches in order to study the possibility to use organic phosphorus preparations of intra-plant insecticidal action for the control of cotton pests.

Effectiveness of mercaptophos and octamethyl with an intensive use of DDT was of special interest in these researches. With this point in view in 1955 wide production experiments were organized in Artashatskii raion of Armenian SSR, in a kolkhoz "imeni Kamo" in Tsakhkashen village.

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Concentrates of mercaptophos and of octamethyl were tested in these experiments; they were received by us in conformance to an order from the interdepartmental commission on insectofungicides in the Section of Plant Protection VASKhNIL.

Concentrate of mercaptophos ("vnuran," systox) contained 50% of active bases (ethylmercaptoethyl-diethylthiophosphate) and 70% of a booster substance OP-7. The concentrate had a yellowish color.

The concentrate of octamethyl contained 56.98% of the active bases (octamethyltetramide of pyrophosphoric acid) of dark brown color, well soluble in water.

Proceeding from preliminary laboratory-field and field experiments in 1953, 54 and 55, we accepted for wide field tests the following concentrations (by weight): mercaptophos--0.05 and 0.1%, octamethyl--0.1 and 0.15%. Higher concentrations, in our tests with cotton, produced morphological changes, brownings on the surface, and occasionally a falling off of leaves.

Spraying was done by a tractor-mounted combination of duster-(Begin p. 144) sprayer-ODM. Cotton was dusted with DDT powder during the season for the control of chewing pests. DDT powder was used together with ground sulfur in a ratio of 1:1. Dusting was also done by the ODM machine or from an airplane.

The first spraying of cotton by mercaptophos and octamethyl was done in the middle of June, the second one in the middle of July. The norm of output of the working solution was: 400-500 l per ha for the first and 700-800 l for the second spraying. Polysulfide of calcium (0.5%)

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and sulfate of nicotine (0.1%) were taken as standards.

Each test occupied from 1 to 2 ha in the cotton plantation. Two basic problems were to be answered by these experiments: 1) to establish a comparative field-effectiveness of mercaptophos and of octamethyl under conditions of wide field-experiments; 2) to investigate the effectiveness of mercaptophos in relationship to Tetranychus urticae Koch. and cotton aphids when spraying them together with the application of DDT on cotton, with and without an admixture of sulfur.

The first experiment was started on a section with a general area about 10 ha. Variety--108-f. First spraying with mercaptophos and octamethyl was done on June 16, the second--July 18. First dusting with DDT powder, mixed with sulfur, was done by a GDN machine on June 21, second--26, the third, from an airplane, on June 30, the fourth, fifth and sixth dustingsfrom an airplane on 19-26 of August and September 7. A norm of output of DDT mixture with sulfur was for the first dusting 40 Kg, and for the following applications 50 Kg per ha.

Calculation and evaluation of infestations of cotton by Tetranychus urticae Koch. and by aphids was done according to a 5-point scale. For every replication of each variant of the experiment 100 to 150 plants of cotton were evaluated on a diagonal line of the section, depending on the size of the section.

It should be said that at the moment of the first spraying by mercaptophos and by octamethyl the experimental section was infested to a medium degree by the cotton aphid (Aphis gossypii Glov), while Tetranychus

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urticae Koch. was practically absent.

The scheme and the results of this experiment are given in table 2.

The second experiment was also started with variety 108-f. The total area of the experimental section comprised about 10 ha. Only mercaptophos was tested here. The first spraying with this preparation was done on June 25, the second on July 16. One half of the same section served as a control, where spraying was done by polysulfide of calcium together with sulfate of nicotine. Nevertheless during the period of the second spraying (in the middle of July) on this half of the section the aphids and especially Tetranychus urticae Koch. started to multiply so vigorously (in foci) that at the kolkhoz's urgent request this section during the time of the second spraying had to also be treated by mercaptophos.

For this experiment during the first three applications DDT was used mixed with sulfur in a norm of output of 40, 50 and 60 Kg per ha. The fourth and fifth treatments were done by pure DDT powder at a rate of 50 Kg per ha. The sixth dusting was done from an airplane with a mixture of DDT with sulfur, (sentence continues after table 2, on page 146)

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Table 2.

Effectiveness of mercaptophos and octamethyl when used together with DDT and sulfur

Preparations	Concentration of the compounds	Infestation of cotton by Tetranychus urticae Koch. and the cotton aphid in %											
		18.VI		23.VI		5.VII		18.VII		5.VIII		10.IX	
		mite	aphid	mite	aphid	mite	aphid	mite	aphid	mite	aphid	mite	aphid
Mercaptophos.....	0.05%	0	3.2	0	5.7	0	1.0	1.7	4.5	0	0	10	0
"	0.1%	0	1.5	0	1.75	0	0.75	0	0.25	0	0	2	0
Octamethyl.....	0.1 %	0	7.5	0.2	1.4	0	0.75	1.5	6.5	0	0	20	3
"	1.1%	0	1.7	0	1	0	0.25	1.25	2	9.7	1.2	56.9	1
First spraying with polysulfide of calcium and sulfate of nicotine.....	0.5%+0.1%	0	11.7	0.7	7.2	10	17.5	7	27.7	15.2	1.7	72.3	3.3
Second-octamethyl.....	0.1%												
Polysulfide of calcium+sulfate of nicotine (control).	—	0	28.7	2.2	19.0	-	-	23	25.2	33.7	26.2	100	-

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at a norm of output of 60 Kg per ha. Results of this experiment are given in table 3.

Table 3.

Effectiveness of mercaptophos when used together with DDT and sulfur during first treatments and pure DDT powder during the following.

Preparations	Concentration	Infestation of cotton in %							
		6.VII		19.VII		29.VII		15.X	
		mite	aphid	mite	aphid	mite	aphid	mite	aphid
Mercaptophos..... During the first spraying polysulfide of calcium and sulfate..... of nicotine and octamethyl during the second spraying.....	0.1% 0.5° and 0.1% 0.1%	1.5 ->	1.3	3.3	1	0	0	20.6	0
		10 ->	8	38	17 ->	3.2	0	55	4.1 ->

The next variant of the experiment, where mercaptophos was used together with pure DDT powder (without any sulfur admixture) was started with variety 12-98 (a more early-ripening variety highly subject to infestation by Tetranychus urticae Koch).

This section was 5 times dusted with DDT powder alone at a rate of 30 Kg per ha (June 27, August 24 and August 30), and one dusting was done from an airplane by a mixture of DDT with sulfur at a rate of 50 Kg per ha.

The first DDT treatment was practically missed because of the delay in the growth of chewing insects on this section. The first spraying with mercaptophos on this section was done June 27 together with DDT. powder, the second on July 19. Data of this experiment are given in table 4.

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Table 4.

Effectiveness of mercaptophos when used with pure DDT powder.

Preparation	Concentration	Infestation of cotton in %							
		6.VII		19.VII		29.VII		15.IX	
		mite	aphid	mite	aphid	mite	aphid	mite	aphid
Mercaptophos.....	0.1%	0.3	0	12	11.3	2	0 ->	33.3	1.8
During the first spraying polysulfide of calcium and sulfate of nicotine and octamethyl.....	0.5%&0.1%	6	28.6	63.3	18.6	60.6	5.6 ->	60.6	0
During the second spraying.....	0.15%								

On the control section DDT was used together with polysulfide of calcium and sulfate of nicotine; however, regardless of the fact that the section was twice, additionally, sprayed with polysulfide of calcium, at the middle of July Tetranychus urticae Koch. multiplied in such numbers, that upon an urgent request from the kolkhoz this section had to be sprayed with octamethyl (0.15%). (Begin p. 147)

Analysis of data of tables 2, 3 and 4 shows that mercaptophos and octamethyl, used in concentrations 0.1 (mercaptophos) and 0.15 (octamethyl), are able to check the mass multiplication of Tetranychus urticae Koch. and of aphids on cotton, when DDT is applied repeatedly.

Even if there is a difference in the total balance of Tetranychus

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urticae Koch. during treatment with DDT powder in pure form or mixed with sulfur together with a double spraying with mercaptophos, it does not have any special practical meaning, because this difference begins to appear in the middle of September, when the mites are not dangerous any more.

A double spraying with mercaptophos is sufficient in order to check the mass growth of mites and of cotton aphids during repeated treatments with DDT.

It is interesting to note that even at the end of September the sections, which were sprayed with mercaptophos, had a healthy green look, whereas the sections which were treated only with sulfur and polysulfide of calcium had a brownish-rusty look and on many bushes of cotton the leaves have completely fallen off.

Although octamethyl has shown a sufficient effectiveness in our experiments, yet mercaptophos considerably surpasses it, which can be partly explained, in our opinion, by a bad wetting capacity of this preparation.

Thus, on the basis of conducted experiments, one can conclude that mercaptophos (and octamethyl) in conditions of the south (Armenian SSR) with irrigation of cotton has a duration of 1-1.5 months in its field activity. We are emphasising the field effectiveness, as, according to our observations, the true duration of the effect of these preparations is shorter. We explain this by the fact, that organic phosphorus preparations of the intra-plant insecticidal action, having exceptionally high acaricidal and insecticidal effects, and mercaptophos having also consider-

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able ovicidal effect, are able in 8-10 days after spraying to wholly cleanse the plants from sucking pests, which cannot be achieved by such acaricides, as are the sulfur preparations (ground sulfur, polysulfide of calcium); their effectiveness does not exceed 80-90% and they have no noticeable ovicidal action. As a result of this, the natural restoration of mites on plants, which are treated with sulfur preparations, proceeds faster.

It is possible to achieve 100% clearing of plants by treatments with mercaptophos. In this case, thanks to the absence of "local infection," the natural restoration of Tetranychus urticae Koch. and of aphids proceeds much slower. The fact that with an artificial infestation the mites begin to acclimatize themselves on the leaves of cotton already in 15-20 days (and sometimes even earlier) after spraying, can serve as a proof of this case.

This circumstance is also confirmed by the fact that on sections, which were treated with octamethyl and mercaptophos, the infestation by Tetranychus urticae Koch. starts much earlier along the roads and canals, where there are weeds, which are natural reservoirs for Tetranychus urticae Koch., than in the rest of the block. (Begin p. 148)

Organic phosphorus preparations of the intra-plant insecticidal action do not have any foot-contact action and almost do not influence the insects on contact, and thus are not dangerous for the entomophagous and acarophagous insects, which is very valuable.

Modern knowledge, concerning this problem, gives a right to suppose that the organic phosphorus preparations of the intra-plant insecticidal

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action, and mercaptophos in particular, will occupy in the near future their proper place in the work of control of sucking pests of cotton and will help to soften that tense condition, which is created by repeated treatments with DDT.

But this question can be definitely solved only after a check up of the nutritive qualities of cotton oil and of fodder qualities of cotton-seed cakes and of other products of seed reprocessing, which were received from the section that was treated with mercaptophos or octamethyl, as there are literary data indicating a possibility of finding mercaptophos in the seeds of cotton [8]. Utilizing a method of tagged atoms, it was possible to detect mercaptophos, with the aid of radioactive sulfur, in the seeds of cotton on the 35th day after the introduction of the preparation into the plant.

It seems to us, that this danger can, to a large degree, be eliminated if the treatment will be done according to a plan when the last spraying of cotton with mercaptophos will be conducted in the middle of July, that is more than two months prior to cotton harvesting.

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Markhaseva, V.A., and Sidorenko, V.A.

Pro vpliv deiakikh faktoriv zovnishn'ogo otochennia na rozvitok zhovtoi irzhi pshenitsi.

[Effect of some environmental factors on the development of yellow rust of wheat]

Mikrobiol. Zhur. v. 16, no. 5, pp. 61-67, 1953. 448.8 K54

(In Ukrainian)

Great damage done by rust to grain crops draws attention of many researchers and practical workers. Many works of Soviet phytopatologists are dedicated to its detailed study. Especially much attention is given to brown rust of wheat, as in its expansion and harmfulness it occupies a first place among the diseases of grain crops.

Less importance is given to yellow rust of wheat. Meanwhile in its harmfulness it surpasses brown rust, and has a considerably negative influence on the plant. Under the influence of yellow rust proceeds a premature dying off and drying of leaves, which, naturally, leads to a disturbance in the process of assimilation. As a result the yields of grain are lowered. As it is stated by M. V. Gorlenko [2], even with very mild infections of wheat, great losses in yields can occur: for instance, in winter wheat Kooperatorka at 0.1% of coverage of leaf surface by pustules of yellow rust the yield decreased by 8.4%.

Damage from the yellow rust is still greater in those cases when it infects also the inner side of the flower scales; in such a case under a direct influence of the pathogen the grain ripens very slowly and becomes

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sickly [7]. According to data of S. A. Kochkin [6], during strong development of the infection the absolute weight of seeds in spikes decreases sharply (doubly when compared to the original seed material). According to his data yellow rust also decreases the productive bushiness of the plants. As a result of this during "rusty" years the yield of wheat under the influence of infection decreases by 30% (Ukrainka, Liutestsens 017) to 60% (Eritrospermum 15).

Nevertheless, in spite of all this damage, yellow rust is of lesser economic importance, because it reaches large expansion only sporadically.

From literary data it is seen that yellow rust is more often found in Leningradskoi, Moskovskoi and partly in Riazanskoi oblast', in foothills of the Northern Caucasus and of Transcaucasus, on high grounds of Kazakhstan, Uzbekistan, Kirghiz republic, in Crimea [2,4,7, 10,11]. Yellow rust is found also in Western Siberia [4,6] and in Gor'kovskii krai [4], but much more rarely.

In the Ukraine, as T. D. Strakhov states [12], the yellow rust is found everywhere, but not every year; and it achieves a strong development only in separate regions, for the most part in the south-west and in Lisostep republic. There is information about the "epifitotiia" (epiphytotic or epiphytotism) of this disease in Ukraine yet in 1914. Thus, in the former Kievskii region (Cherkasskii, Kanivs'kii, Zvenigorodskii and other districts) the infection of wheat was so great (Begin p. 62) that in many cases it could not even reach the heading stage. Losses from rust in that year were to 25%.

Area of expansion of yellow rust is determined to a large degree by

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ecological characteristics of its pathogen--Puccinia glumarum E. et. H. Undoubtedly, that in this respect the regionalizing of wheat varieties is of great importance; their diverse resistance to this disease.

Puccinia glumarum is very sensitive to the temperature. It adapts itself to comparatively low temperatures and falls into a depressed state at a high temperature of air. The best temperature for germination of uredospores of P. glumarum os between 10-20°, but at temperatures below 5° the ability to germinate decreases [7].

Infection of plants by P. glumarum, that is the penetration of the mycelium of the fungus into the tissue of the host is done easier at lower temperatures (around 14°), but at temperature of 24-25° infection does not take place [8].

The length of the incubating period of yellow rust, according to data of N. A. Naumova, also depends on the temperature; this period grows with a decrease of daily temperature (average, maximum, minimum). Best conditions for development of the fungus inside the tissue of the plant-host (this is the shortest incubation period that the author could observe) were 8 days with an average temperature of 10° and extreme fluctuations of daily temperatures 15-25° [8].

There are some indications in literature about the great importance of moisture for the development of yellow rust. N. A. Naumov thinks that not only the moment of the original infection, but also the rate of speed of the subsequent development of the yellow rust depend besides the temperature also on the amount and frequency of rain, and in this is the essential difference between yellow and brown rust; for the development of the last

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one moisture is not a deciding factor. From this ensues Naumov's conclusion, that in years and in regions with moist, cool summers favorable conditions for intensive spreading of P. glumarum are created.

E. P. Kotova indicates that in 1936 in many raions there were favorable conditions for the growth of yellow rust in connection with the decrease of temperature in May and a considerable (from moderate to high) moisture in June. She gives an exclusive importance to June precipitations.

E. P. Kotova also points out the dependence of development of this disease on the presence of sufficient moisture, on sharp fluctuations of temperature, especially in the early spring period. On account of this, in the author's opinion, in mountainous terrain where daily fluctuations of temperature are usual and extreme, yellow rust appears nearly every year and in the flat country only sparodically.

In places with hot summers, as in Caucasus, the intensive development of the cited disease takes place only in foot-hills, where temperature is lower and moisture is high [10].

According to data of S. A. Kochkina in Issik-Kul's'kii lowland of Kirghiz the heaviest infections of winter wheat happen in years with greater amount of rains and with the highest relative humidity of air during the period "from the beginning of the spring vegetation and to heading stage, and from the heading stage to ripeness with a comparatively low temperature during the rest of the period" [5].

But there is in literature another evaluation of the role of humidity, in regard to yellow rust. N. A. Naumova, by special experiments proved that the relative humidity of the air does not influence the duration of

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the incubation period and is not a deciding factor for the development of yellow rust [8].

Conclusions of N. A. Naumova find a corroboration in data which we are giving below on the development of yellow rust in 1960, when this disease was observed on winter wheat in many raions of the Pravoberezhzhia [right bank] of Ukraine. During some of the months its development was very noticeable. Temperature conditions were quite favorable for the development of the disease: low temperature in May-June with sharp fluctuations from maximum (Begin p. 65) to minimum, himidity of the air was rather low, because there were very few rains.

On the experimental base of the Institute of Entomology and Phytopathology of Academy of Science of the Ukrainian SSR, we also observed the development of yellow rust on winter wheat under conditions of insufficient moisture, which neared the conditions of drought.

In May the weather was comparatively cool. The mean monthly temperature was 15.3°; no sharp fluctuations of temperature were observed; as the maximum so also the minimum were favorable to germination of spores of P. glumarum. There were few rains; their total sum for May was 6.7 mm. Such conditions preceded the first appearance of yellow rust on winter wheat, which were obsefved in the beginning of June during the time of ripening.

During the milk stage of ripeness of the winter wheat the disease already has considerably spread to the leaves of the upper tier and partly to the spikes' scales encompassing on some varieties (in particular, variety Ukrainka of a late sowing) a great number of plants with an intensity of infection from 30 to 80% and higher.

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During the period of development of the disease (from its first appearance and to the milk stage of ripeness of wheat) the temperature was in the best limits, and the relative humidity of air was very low (mainly 26-40%), with the exclusion of some days when it rose to 50-70%. There were few rains. Only 6 days had short and sparse rains of 0.7-1.6 mm per day.

Thus, from the above data, it is seen that lack of moisture, in the presence of favorable temperature, is not a hindrance to the development of yellow rust.

In 1951 yellow rust developed on a larger scale than during the foregoing year; at the same time it was seen not only on the Pravoberezhzhi, but also on the Livoberezhzhi [left bank], mainly in the forest-steppe zone of Ukrainian SSR, and not only on winter wheat, but on spring wheat also. Among spring wheat varieties even Lutestsens 062 was affected.

On the experimental base of our Institute yellow rust was also strongly developed and already during the stages of heading--blooming of winter wheat (at the beginning of June) almost 100% of plants were affected and on leaves of all tiers. Intensiveness of infection was great, so that at the beginning of the milk stage, under the influence of yellow rust, all the leaves dried up.

The scales of the spikes were also infected to a considerable degree. On the average about 92% of spikes were infected, out of which 45% to a high degree.

Yellow rust appeared also on spring wheat: Arnautka Nemerchans'ka and Artemivka.

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In 1951, in contradiction to 1950, there was plenty of precipitation. 92 mm in May, and 47 mm of rain in June were noted on our experimental base. The temperature for the development of the fungus was most favorable: in May the mean temperature was 13.8°, with a maximum of 17° and minimum 11.2°; and correspondingly in June was 19.7, 22.4 and 16.8°. The most favorable temperature conditions had place in other points of Ukrainian SSR also in connection with considerable moisture.

From comparative two-years data we see that with almost similar temperature conditions (which are favorable for the growth of the pathogen) the development of yellow rust proceeded during adequate dampness as well as during low humidity. Thus, humidity is not a basic factor for the growth of the given disease. As in brown rust, humidity is important only at the moment of infection, that is, during the germination of uredospores P. glumarum. We link a stronger development of rust in 1951, than in 1950, to the infection of wheat at an earlier phase of vegetation and not to a high relative humidity of air. The increase of the infection in 1951 depended, to a considerable degree, on the condition of the plants themselves, which were weakened in connection with unfavorable (Begin p. 64) temperature conditions for their development in spring and beginning of summer. This index, a condition in which the plants are--is the essential one because it calls forth the reaction of the plant to the pathogen.

Meanwhile in literature the question about yellow rust is being asked as if the development of this disease depends only on conditions for the growth of pathogen itself, and the importance of such conditions for the plant-host is not taken into consideration.

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Such an approach for evaluation of factors which cause the development of rust only from the point of view of their importance to the pathogen is onesided and untrue, as yellow rust, like any other parasitic disease, is an heir to the reactions of two organisms - of the pathogen and of the plant-host, which manifest themselves on the basis of certain conditions of outside environment. Therefore, speaking about conditions for development of the yellow rust, we must take into consideration not only the conditions for growth of the pathogen itself, but also the full complex of factors, which affect the plant: they mean one or another reaction of the plant to the pathogen, and thus determine the course of the disease, the degree of its progress.

Among the factors, which influence in a certain way the condition of the plant, or its receptivity to the disease, besides the meteorological conditions, of great influence are the agrotechnical methods for growing the crops. N. A. Maumov [7] attaches exceptional importance in the matter of control of yellow rust to high agrotechnics and evaluates it as a factor, which increases the resistance of the plant to the disease. Undoubtedly, this situation spreads to the yellow rust also.

Many works are devoted to studies of influence of fertilizers on the development of different kinds of rust; however, we have no knowledge of any special research in this respect concerning yellow rust of wheat.

Studying the influence of feeding on the development of some diseases of spring wheat, we had an opportunity to evaluate the influence of individual fertilizers on the infection by yellow rust. We investigated manganese tails and kitchen salt in combination with basic fertilizer NPK, as also the

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combination of NPK with supplementary doses of potassium salt and of superphosphate.

All these fertilizers were introduced during sowing into the rows, computing per hectare: of manganese tailings--1 c, of kitchen salt--1.5 c, of potassium salt--2 c and of superphosphate--4 c. The sowing was done by hand, down a board. The experiment was in four replications. The area of the experimental field was 10 m^2. The extent of the test, when making calculations on rust, was 20 plants from each section. Time of accounting was the beginning of milk stage of ripeness. Variety of spring wheat--Arnautka Nemerchans'ka.

Data of evaluation of fertilizers is given in table 1.

Table 1.

Influence of fertilizers on the infection of spring wheat by yellow rust in 1951 (mean for 4 replications)

Variants of experiments	Spreading		Progress of disease		Yield	
	% of infected plants	% in the control	%	in % for the control	in g from the section	in % for the control
NPK -- control	40.0	100	16.1	100	240	100
NPK + manganese tails	26.2	65.5	9.2	57.1	266	110.8
NPK + kitchen salt	21.2	53.0	7.1	44.0	242	100.8
NPK + potassium salt	36.2	90.5	10.6	65.7	248	104.1
NPK + superphosphate	37.6	93.7	14.3	88.8	282	117.5

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(Begin p. 65)

From the cited data it is seen that under the influence of tested fertilizers the infection of wheat decreased to one or another degree and the yield increased at the same time. Kitchen salt and manganese tails in combination with NPK are the most effective among fertilizers in the decrease of growth of yellow rust.

In literature there are indications that the infection of wheat by brown rust decreases under the influence of manganese fertilizers, of kitchen salt, of potassium and, partly, phosphorus fertilizers [1, 7, 9].

Our data show, that these indications can be applied also to yellow rust. However data on the positive influence of fertilizers, and chiefly of manganese tails and of kitchen salt were obtained from a one-year field experiment, and, besides, from experiments with a variety of spring wheat Arnautka Nemerchans'ka which is but weakly affected; thus they cannot be judged sufficient for final conclusions. We evaluate them only for a first, tentative conclusion which shows the possible way in the heightening of resistance of wheat to yellow rust; in connection with this, studies about manganese tails and kitchen salt as factors, which restrain the development of the cited disease, have great possibilities.

The importance of the variety appears sufficiently clear in the restraint of the development of yellow rust. Our observations of the development of this disease on different varieties in the course of two years show, that under similar conditions, different varieties are affected diversely (see tables 2 and 3). The place of observations--Experimental Base of the Institute.

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Table 2.

Infection of different varieties of winter wheat by yellow rust in 1950.

(mean for 4 replications)

Name of variety	1st date of planting 29.VIII		2nd date of planting 6.X	
	% of infected plants	% of development of disease	% of infected plants	% of development of disease
Bilotserkivs'ka 200	27.5	11.0	37.5	18.0
L'govs'ka 3612	20.0	6.5	56.0	30.0
Triumf Podolii	20.0	7.5	59.0	28.0
Ukrainka	40.0	17.6	97.5	50.6
Liutestsens 017	41.6	19.1	-	-
Kharkivs'ka 917	55.0	27.5	64.0	41.7

Table 3.

Infection of different varieties of winter wheat by yellow rust in 1951

(mean for 4 replications)

Name of variety	1st date of planting 7.IX		2nd date of planting 6.X	
	% of infected plants	% of development of disease	% of infected plants	% of development of disease
Triumf Podolii	22.9	9.1	11.2	8.7
Bilotserkivs'ka 200	23.7	10.5	28.7	18.9
L'govs'ka 3612	48.7	20.9	36.8	15.8
Kharkivs'ka 917	44.1	19.1	59.9	37.2
Liutestsens 017	92.9	67.4	74.7	57.2
Ukrainka	96.6	60.6	80.0	68.4

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From among winter wheats the least infected were varieties: Bilotserkivs'ka 200, L'govs'ka 3812, Triumf Podolii as at the first (normal) date of planting, so also at the later date. At that, according to 1950 data, infection increased on all varieties at the second date of planting, which, most likely, is connected with a late appearance of the disease; the later date of planting (Begin p. 66) appeared to be the most favorable for the infection. In 1951 another dependence was observed.

For spring wheat infection of different varieties was also dissimilar. Thus, in variety Artemivka 65% of infection of plants was noted at 30.2% development of disease, and in variety Arnautka Nemerchans'ka correspondingly it was 40% and 16.1%.

On the basis of observations and of tentative field experiments in 1950 and 1951, it is possible to make such conclusions:

1. In the dynamics of development of yellow rust of wheat the temperature conditions of the spring-summer period are the basic factor, and humidity is of secondary importance. Final decision in the course and outcome of disease depends on the state of the plant-host, which determines its reaction to the pathogen at certain meteorological conditions.

2. Under the influence of some fertilizers the affection of wheat by yellow rust can be reduced; in our experiment manganese tails and kitchen salt appeared to be the most effective for spring wheat.

3. Different varieties of wheat are affected by yellow rust in a different manner. From among the tested varieties under conditions of 1950 and 1951 the little infected were Belotserkivs'ka 200, Triumf Podolii,

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L'gov's'ka 3612, and strongly infected were Ukrainka, Liutestsens 017, and partly Khar'kivs'ka 917. From among spring wheats Artemivka was stronger infected than Arnautka Nemerchans'ka.

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Translation A-728
(In full)
bn/M

Turchin, F.V., and others

Issledovanie azotnogo pitaniia i obmena u rastenii s primeneniem izotopa N^{15}.

[Investigation of nitrogen nutrition and metabolism in plants by using N^{15} isotope]

Pochvovedenie, no. 7, pp. 1-12, July, 1955. 57.8 P34

(In Russian)

Study of the process of conversion of mineral nitrogen in plants into proteins was always one of the central problems of agronomical and biological chemistry. But up to the recent time many of our ideas in this field were based rather on hypothesis, than on facts, which are acquired as a result of exact experiment. The main difficulty consisted in the impossibility to delineate nitrogen, which has newly entered the plant or its newly synthesized compounds (amino acids, proteins) from similar compounds already present in the plant. This excluded the possibility of conducting an exact count of all those changes which the mineral nitrogen undergoes on the way of its entry from the soil through the roots of plants up into its localization in the protein of leaves or seeds of plants.

Utilization of tagged atoms in biology, which has lead to such great successes in scientific development of many important questions, also renders an invaluable service in researches of nitrogen nutrition and of nitrogen metabolism in the plants. Using ammonium sulfate, ammonium nitrate, or any other compounds of nitrogen, which are enriched by N^{15} isotope, as

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a source of nitrogen for the plants, and evaluating later the contents of N^{15} isotope in the nitrogen compounds which were isolated from the plants, it is possible to answer a question, quite definitely, how fast nitrogen enters one or the other organ of the plant, with what speed and in what organs and tissues of plants are formed the nitrogeneous-organic compounds, which interest us, and what is their further destiny in plants. At this point it is very important to note the case, that isotope N^{15} of nitrogen, in its reaction on a living organism in any concentration, does not differ from the usual nitrogen. When utilizing ammonium salts or nitrates, enriched with N^{15} isotope to the utmost, they will react in plants exactly in the same way as do the usual ammonium salts and nitrates. The isotope N^{15} does not produce any toxic or, inversely, any stimulating influence on plants or animals.

In this work the basic results of our investigations on nitrogen nutrition and metabolism in plants are set forth, which were conducted in the last two years with the use of N^{15} isotope. Plants, for these investigations, were grown in the vegetative pavilion in peat-sand or water cultures. The nutrient medium, which was applied before the plants were sowed, included nitrogen, usually in a dose 0.3N per vessel in the form of plain ammonium sulfate, as well as all other macro and microelements in normal doses. When the plants achieved a specific age, they were given a nitrogen top dressing in the form of ammonium sulfate, enriched by N^{15} isotope. The rate at which nitrogen was enriched with isotope N^{15} in the top dressing of ammonium sulfate was changed for each test in a wide range, from threefold to 40-fold. Owing to the fact that at the moment of application of N^{15} isotope tagged

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nitrogen, top dressing in the vessels remained in one or another amount a portion of regular nitrogen (which was applied before planting) and was yet unused by the plants, the actual enrichment (Begin p. 2) of nitrogen by N^{15} isotope in the nutrient medium in the vessel fluctuated for individual tests from 2 or 4-fold to 25-fold. At specific periods of time after the introduction of tagged nitrogen top dressing the plants were removed and taken for analysis. As a rule, for each experiment several dates for the removal (not less than six) were established in order to have a more or less full curve of nitrogen conversion in plants, in time. The length of exposure of plants to the tagged nitrogen top dressing was changed for separate tests from 15 min. to 240 hours. Simultaneously with the test plants, the control ones were also removed; they were not given the supplementary nitrogen feeding. Comparing data of analysis of the control plants with results of analysis of test plants, it is possible to estimate the quantitative changes in the contents of investigated fractions of nitrogen in plants, which were produced by the application of tagged nitrogen top dressing; this in many cases is absolutely necessary for a correct interpretation of data of the isotope analysis.

In the harvested plants the evaluation was done to the inorganic nitrogen (ammoniacal N), to nitrogen of organic non-protein compounds, which is represented in test plants basically by amino acids, to chlorophyll nitrogen, to nitrogen of colloido-soluble proteins and to nitrogen of insoluble cell proteins. The method for isolation of these compounds of nitrogen was described previously (5). In view of their high mobility, the colloido-soluble proteins, in conformity with the accepted subdivi-

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sioning of proteins in the green parts of plants, we will in the future designate as reserve proteins, and the less mobile, insoluble cell proteins, as constitutional proteins.

These groups of protein substances differ considerably in the composition of their amino acids.

Analyses, which were made in our laboratory by V.M. Makarevich, have shown that the reserve proteins of all tested plants did not contain any proline at all, and that they are much richer in tryptophan, alanine, valine and leucine, than the constitutional proteins.

The fractions of nitrogen, which were isolated from the plants, were then burned, according to Kjeldahl, and after distilling and collecting the ammonia, were converted, under vacuum, into elementary nitrogen, which was then taken for isotope analysis on the mass-spectrometer. Measurements on the mass-spectrometer give the rate of enrichment by N^{15} isotope of a tested sample of nitrogen. According to an experimentally found rate of enrichment by N^{15} isotope, the rate of renewal of nitrogen of an investigated fraction was computed according to the following formula:

$$N^{New} = \frac{A_1 - 1}{A - 1} : 100,$$

where N is the renewed N, in per cent; A--enrichment by isotope N^{15} of the initial source of nitrogen; A_1--enrichment by N^{15} isotope of the investigated compound of nitrogen; the contents of isotope N^{15} in the regular nitrogen (0.39%) are accepted as a unit-1.

Tagged ammonium sulfate, which was utilized as top dressing, and whose ammonium nitrogen is directly used for synthesis of amino acids and of amides was taken as an initial source of nitrogen when making calculations

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of the rate of renewal of amino acids and of amides (non-protein organic nitrogen). It is not ammonia as such, but the amino acids, synthesized at its expense, which are used for the synthesis of protein and chlorophyll. Consequently, when calculating the rate of renewal of nitrogen in protein and in chlorophyll, the rate of enrichment by N^{15} isotope of the nitrogen of amino acids, which are the direct forerunners of protein in the process of its formation in the plants should be taken as the initial value (A). Data obtained in an experiment with oats in 1953 are given in table 1 and table 2.

Top dressing by tagged nitrogen in this experiment was conducted 24 days after the appearance of sprouts. Ammonium sulfate, with triple enrichment by isotope N^{15} was used as top dressing in a dose (Begin p. 8) of 0.24 g N per vessel. As the tagged ammonium sulfate, which was utilized for top dressing, became diluted by the regular ammonium sulfate, that was introduced before sowing, and was not yet fully consumed by the plants, the actual enrichment of ammonium sulfate in the substrate was then somewhat lower, namely 2.6.

From table 1, where data of yields as also results of the chemical analysis of plants are given, it follows, that when the plants are exposed to the tagged nitrogen from 6 to 72 hours, the weight of plants remained practically on the same level; it increased considerably only 120 hours after the application of nitrogen top dressing.

In the plants the contents of non-protein organic nitrogen (free amino acids) continually increased the longer the exposure to the tagged nitrogen proceeds. The content of nitrogen of the constitutional and reserve proteins during exposure to tagged nitrogen for 6 to 72 hours

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increased, on the whole, with the lengthening of the exposure, but only to a slight degree. Considerable increase in the content of protein nitrogen in the plants occurred only at longer exposures, of 120 and 240 hours.

An increase of chlorophyll content in plants also became quite noticeable only at longer exposures (120 and 240 hours).

However, from data shown in table 2, it appears that tagged nitrogen, used for top dressing was detected in protein fractions and in chlorophyll already in 12 hours; in subsequent periods content of isotope N^{15} in protein and chlorophyll rose continuously and after 72-120 hours the rate of enrichment by isotope N^{15} of proteins and of chlorophyll virtually became equal to the degree of enrichment by isotope N^{15} of the non-protein organic nitrogen. Thus, in spite of the fact that the general amount of protein and chlorophyll in the plant, in the course of 72 hours after introduction of the tagged nitrogen top dressing, changed very slightly, the nitrogen composition of these substances in the plants was undergoing at the same time an intensive renewal.

As is seen from data given in table 2, nitrogen of constitutional proteins and of chlorophyll, in the period of 72 hours was renewed 90-95%, and after 120 hours in plants of this experiment there occurred a practically full renewal of nitrogen in the protein and chlorophyll.

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Table 1.

Yield of green weight of oats and content in it of individual fractions of nitrogen at different periods after the application of tagged nitrogen, as top dressing, in 1955.

Length of exposure of plants to N^{15}, in hours	Weight of green mass of plants in g per vessel	Nitrogen in mg N per vessel				
		organic, non protein	reserve proteins	constitutional proteins	chlorophyll	inorganic compounds (NH_3 and others)
6	49.1	54	81	127	5.8	none
12	48.3	64.5	78	151	5.8	"
24	52.6	76.4	82	136	6.2	"
36	52.3	80.1	9	139	6.3	"
48	50.0	76.0	100.3	146	6.7	"
72	49.0	90.0	94	158	5.8	"
120	68.9	95.0	156	148	8.9	"
240	80.3	107.0	150	210	9.80	"
Control variants without nitrogen top dressing.	49.0	50.0	76	124	5.9	"

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(Begin p. 4)

Table 2.

Results of isotope analysis of individual fractions of nitrogen, isolated from the green mass of oat plants, in 1953.

Length of exposure of plants to N^{15} (threefold enrichment (in hours)	A detected enrichment by N^{15} isotope				% of renewed nitrogen		
	organic non-protein nitrogen (amino acids)	nitrogen from reserve proteins	nitrogen from constitutional proteins	nitrogen from chlorophyll	reserve proteins	constitutional proteins	chlorophyll
6	1.07	1.00	1.00	1.00	0.0	0.0	0.0
12	1.32	1.06	1.15	1.07	18.7	40.6	21.9
24	1.53	1.13	1.28	1.14	24.8	53.0	26.5
36	1.82	1.15	1.46	1.36	16.5	56.0	44.0
48	1.75	1.28	1.47	1.43	57.4	62.6	57.5
72	1.85	Undeterm.	1.77	1.81	-	91.0	95.0
120	1.93	1.85	1.96	Undeterm.	91.0	100	-
240	1.95	1.98	2.02	*	100	100	-

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Renewal of the nitrogen composition of protein and of chlorophyll is dependent on two processes which are proceeding in the plant simultaneously--new synthesis of protein and chlorophyll, result of which is the growth of mass of these substances, and by the process of self-renewal of protein and of the pyrrole ring of chlorophyll. A full or partial decomposition of these substances with their subsequent re-synthesis at the expense of amino acids from the metabolic fund of the plant occurs in this last instance. From data of the chemical analysis of plants it is seen, that in the first 72 hours after application of the tagged nitrogen top dressing, the content of chlorophyll in plants virtually did not change; thus the renewal of nitrogenous composition of the pyrrole ring of chlorophyll which took place in these periods can be fully attributed to a continuous process of self-renewal.

The rate of renewal of nitrogen composition of constitutional and reserve proteins, conditioned by their new synthesis during the exposure of plants to N^{15}, calculated according to data of chemical analysis, is brought forward in table 3. By comparing these data with the actual renewal of nitrogen composition of proteins, which was established by the isotope analysis, it appears, that a renewal of protein, which occurred in the first hours of exposure of plants to the tagged nitrogen can be only slightly conditioned by its new synthesis at the expense of the tagged nitrogen, introduced as top dressing.

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Table 3.

Nitrogen from protein, which was synthesized by plants at the time of their exposure to N^{15}.

(An experiment with oats in 1953)

Length of exposure of plants to N^{15} (in hours)	In % to the total protein nitrogen (according to chemical analysis)		% of renewed nitrogen of proteins according to data of isotope analysis	
	Constitutional proteins	Reserve proteins	Constitutional proteins	Reserve proteins
6	2.4	6.1	0	0
12	5.2	2.6	40.6	18.7
24	8.2	7.2	53.0	24.8
36	10.6	17.0	56.0	18.3
48	16.4	23.4	62.6	37.4
72	22.8	17.0	91.0	Undeterm.
120	16.2	51.0	100	91.0
240	50.0	49.3	100	100

(Begin p. 6)

At a longer exposure the amount of the newly synthesized protein is increasing noticeably and its role is rising accordingly in renewing the nitrogen composition of the whole mass of protein.

Thus, from the results of this experiment it follows, that in the plants, besides the new synthesis of protein and chlorophyll, a process

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of self-renewal of these substances is continuously taking place. This process proceeds especially intensively in young plants. In the given experiment, in the course of a 48-hour exposure of plants to the tagged nitrogen about 60% of nitrogen of the constitutional proteins and of chlorophyll were renewed, although the total content of protein and of chlorophyll in plants, in the limits of this time, changed very insignificantly.

At longer exposures of plants--at 120 and 240 hours--the experimentally found enrichment by isotope N^{15} of all the fractions of nitrogen, which were isolated from the plants (non-protein organic nitrogen, protein nitrogen and the chlorophyll nitrogen) is expressed by an identical rate, which is proof of the full renewal of nitrogen composition of protein and chlorophyll which occurred during this time.

From results of this test it also follows, that the speed of renewal of two groups of protein substances, which we isolated from the plants, the constitutional and the reserve proteins, is quite distinct. The constitutional proteins are being renewed with a considerably greater intensity, than do the reserve proteins. In other experiments, with a shorter exposure of plants to N^{15}, tagged nitrogen could be detected in constitutional proteins at earlier dates, than in the reserve proteins. This gives a certain foundation to suppose, that the constitutional proteins are synthesized first, then by undergoing specific changes, they are converted to the more active reserve proteins.

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Table 4.

Contents of individual forms of nitrogen in plants at different lengths of exposure to N^{15}

(An experiment with winter rye)

Length of exposure of plants to N^{15} in hours	Weight of raw green mass in plants in g	In mg N per 100 g of raw green mass of plants			
		non-protein nitrogen	reserve proteins	constitutional proteins	chlorophyll
2	30.0	100.6	138	135	12.2
4	32.5	95.9	149	146	11.1
8	31.3	91.7	143	144	11.7
12	33.0	105.6	1 2	147	11.9
24	33.9	164.3	142	167	13.0
36	32.1	169.4	160	188	13.8
48	30.5	229.8	159	180	12.2
72	34.1	225.5	192	192	13.9
Control, without top dressing	32.5	95.2	139	141	12.3

The nitrogen metabolism in the roots and in the aboveground green mass of plants was studied in an experiment with winter rye, which was conducted in August, 1953. Top dressing by tagged nitrogen was applied 25 days after the appearance of sprouts.

Ammonium sulfate with a quintuple enrichment by isotope N^{15}, in a dose of 0.24 g per vessel was used as top.dressing. The test was done in water

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cultures.

In tables 4 and 5 are shown data of yields and results of chemical analysis of the green mass and roots of plants.

(Begin p. 8)

Table 5.

Contents of individual forms of nitrogen in roots at different lengths of exposure of plants to N^{15}

(Experiment with winter rye)

Length of exposure of plants to N^{15} in hours	Green weight of roots in g	In mg N per 100 g of raw root mass		
		non-protein nitrogen	reserve proteins	constitutional proteins
2	31.2	25.3	18.4	106.5
4	32.3	30.4	22.1	83.0
8	32.3	32.0	29.7	88.7
12	35.0	51.0	37.2	86.7
24	34.5	49.7	31.7	91.7
48	28.8	61.6	37.3	90.0
72	32.6	80.9	33.5	89.7
Control without top dressing N^{15}	32.0	22.4	17.4	88.9

Data of chemical analysis of the green mass of rye (table 4) are approximately of the same type with the corresponding data obtained in the experiment with oats, in 1953. In the first hours of exposure of

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plants to the tagged nitrogen the content of both protein fractions in the green mass remained practically on the same level, and only at 36 hours of exposure occurred a sufficiently noticeable increase in the content of chlorophyll during the time of exposure of plants to N^{15}.

Table 6.

Results of isotope analysis of individual fractions of nitrogen, isolated from the green mass of winter rye in 1953.

Length of exposure of plants to N^{15} in hours	Enrichment by N^{15}				% of renewed nitrogen			
	non-protein N	reserve proteins	constitutional proteins	chlorophyll	non-protein N	reserve proteins	constitutional proteins	chlorophyll
2	0	0	0	0	0	0	0	0
4	1.03	0	1.003	0	0.75	0	0	0
8	1.40	1.022	1.06	0	10.0	5.5	14.9	0
12	1.69	1.031	1.12	Undeterm	17.2	4.5	17.4	Undeter.
24	2.03	1.153	1.30	1.29	25.8	14.8	29.1	28.1
36	3.40	1.565	2.00	1.58	60.0	25.5	41.7	24.2
48	3.14	1.77	1.98	2.06	55.4	35.9	45.7	49.2
72	3.61	2.59	2.44	2.16	65.5	60.8	55.3	44.6

Non-protein organic nitrogen remained without change during the first 8 hours. In the subsequent hours of exposure the content of non-protein nitrogen rose continuously, and to the end of the experiment it increased more than two times compared to the initial condition of the plant.

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Somewhat different results were obtained during the analysis of rye roots (table 6). There the content of constitutional proteins remained practically without change during the full 72 hours of the experiment. On the other hand, the amount of reserve proteins in the roots, beginning with the 4-hour long exposition, rose fast, and already in 24 hours, after the introduction of tagged nitrogen top dressing, the amount of nitrogen in the reserve proteins had doubled compared to the initial state.

In tables 6 and 7 are given results of the isotope analysis of individual (sentence continued after table 7) (Begin p. 7)

Table 7.

Results of isotope analysis of individual fractions of nitrogen, isolated from roots of winter rye, 1953.

Length of exposure of plants to N^{15} (quintuple enrichment) in hours	Enrichment by N^{15}			% of renewed nitrogen		
	non-protein N	reserve proteins	constitutional proteins	non-protein N	reserve proteins	constitutional proteins
2	1.69	1.15	1.16	14.8	22.0	27.1
4	1.84	1.10	1.14	20.9	11.9	16.7
8	1.90	1.22	1.17	22.6	22.6	18.8
12	2.08	1.24	-	27.1	11.0	-
24	2.50	1.31	1.47	37.5	20.7	31.4
48	3.12	1.69	-	58.0	27.8	-
72	3.73	1.77	1.94	67.6	33.0	40.7

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fractions of nitrogen, which were isolated from the green mass (table 6) and from roots (table 7) of plants.

Data of isotope analysis show, that the formation of non-protein organic nitrogen in the roots of plants at the expense of the conversion of the tagged nitrogen introduced as top dressing, from ammonium sulfate, occurs on a considerable scale already in the first 2 hours of the experiment; during that time the non-protein organic nitrogen was renewed by 14.6%. In the following hours of the experiment the renewal of this fraction of nitrogen rose sharply, which fully corresponds also to data of chemical analysis. It is necessary to note that in other experiments, which were conducted at shorter exposures, a new formation of amino acids in plant roots was discovered even after 15 minutes after introduction of the nitrogen top dressing. Formation of new amino acids (non-protein organic nitrogen) in the green mass of young plants of winter rye starts in 4 hours after introduction of tagged nitrogen top dressing. In the interval between 4 and 36 hours intensiveness of synthesis of amino acids, at the expense of tagged nitrogen, which was introduced as top dressing, increased sharply, which is conditioned by a corresponding intensification of entry of nitrogen from roots into the above ground parts of plants.

The tagged nitrogen was detected in constitutional and reserve proteins of roots already at a 2-hour exposure of plants to N^{15}, which points to an exceptionally high speed of combination of the introduced source of nitrogen into protein molecules of the plant roots. In constitutional proteins of green leaves the tagged nitrogen was detected already in 8 hours

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after application of the tagged nitrogen top dressing. Thus, under conditions of this experiment the whole process of nitrogen conversion, beginning with its entry from the soil and ending with its inclusion into the composition of the protein molecule of the leaves of plants, was covered in the course of 8 hours. As seen from data of isotope analysis, a continuous renewal of the nitrogenous composition of protein and of chlorophyll proceeded in the green mass of rye. The rate of this process exceeded by several times the intensiveness of the new formation of protein and chlorophyll (new formation which leads to an increase of the general mass of protein and chlorophyll in plants). That is why, one can assume with sufficient reason, that the renewal of protein and of chlorophyll in this experiment, as well as in the above cited experiment with oats, is basically conditioned by spontaneous partial or full disintegration of the molecule of protein or of the pyrrole ring of chlorophyll with a simultaneously proceeding process of their reconstruction. In the roots of rye the intensiveness of the protein renewal is considerably lower, than in the green mass, which indicated a substantial difference in the protein metabolism in the roots and in the green parts of plants. But in this experiment (Begin p. 8) especially interesting data was obtained for reserve proteins of the roots. From data cited in table 5 of the chemical analysis it follows, that the content of nitrogen of reserve proteins in roots rises intensively with the lengthening of the exposure of plants to tagged nitrogen top dressing. At the same time the renewal of nitrogen of this fraction of protein, calculated according to data of isotope analysis, starting with

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the first 2 hours of exposure and to the end of the experiment, is characterized by a comparatively small amount.

According to data of the chemical analysis one can figure out the percentage of a partial participation of the newly synthesized protein in the general mass of the whole protein. This will be an indicator of its renewal, conditioned only by the growth of the general mass of protein.

Comparison of this calculated data with the renewal of nitrogen of the reserve proteins, which was established according to data of isotope analysis, gives the following picture (table 8)

Table 8.

Change in the content of nitrogen of reserve proteins in rye roots and in the rate of its renewal at different exposures of plants to N^{15} according to data of chemical and isotope analyses.

Length of exposure of plants to N^{15} in hours	Increase in contents, compared to control variants (chemical analysis) in mg N per 100 g of roots	Rate of renewal	
		Chemical analysis	Isotope analysis
2	2.0	5.4	22.0
4	4.7	21.2	11.9
8	11.3	38.2	22.5
12	19.8	52.2	11.0
24	14.3	45.3	20.7
48	19.9	53.4	27.8
72	16.1	48.0	33.0

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Thus, the renewal of nitrogen of reserve proteins in the roots, which was established according to data of isotope analysis, at all hours of exposure of plants was considerably lower than it should have been, if one judged only according to the gain in the protein mass, and had not taken into consideration the continuously flowing process of self-renewal of protein. Especially significant is the break between data of isotope and of chemical analyses for exposures from 4 to 48 hours. Such non-correspondence between the quantity of reserve protein, which was formed during an exposure of plants to the tagged nitrogen, and the rate of enrichment of this protein by isotope N^{15} could not have been if the newly formed reserve protein was built at the expense of the tagged nitrogen which was introduced as top dressing. A comparatively low rate of enrichment by isotope N^{15} of the reserve protein of the roots, together with a sharp increase of its general content, which occurred after introducing the tagged nitrogen top dressing, can be explained only in that case, if one allows an exogenous "non-root" formation of the greater part of the reserve protein, which was found in the roots after the introduction of the tagged nitrogen top dressing. In this manner we can make but one deduction, that the content of reserve proteins in roots, with an introduction of nitrogen top dressing, increased as a result of an influx of mobile reserve proteins from above-ground plant organs, in this case from the green mass of rye. As the tagged nitrogen, which was introduced as top dressing, was incorporated into the composition of reserve proteins of the green mass of rye later, it is then understandable, that the influx of reserve proteins from the green mass into the roots produced a corres-

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ponding lowering of the rate of enrichment by isotope N^{15} of the whole mass of reserve proteins in the roots. One can assume that the conversion in the plant roots of inorganic (Begin p. 9) nitrogen into amino acids will be accomplished with the aid of reserve proteins which can be bearers of corresponding enzyme systems, which catalyze the reaction of synthesis of amino acids in plants. With an increased influx of inorganic nitrogen the content of these proteins in the roots appears to be insufficient and the plants react to this by translocating an appropriate amount of mobile reserve proteins from the leaves into the roots. Data, which were obtained in one of our experiments while studying synthesis of amino acids in roots during introduction of nitrogen top dressing in the form of ammonium nitrogen, speak also partially in favor of such a supposition.

In the first hours after the introduction of nitrogen top dressing, the content of unconverted ammonia in roots rose, but later, after a 12 hour exposure of plants to nutrient medium with ammonium nitrogen, it gradually fell with a simultaneous increase in intensity of synthesis of amino acids, and in 72 hours after the introduction of nitrogen top dressing it was possible to find only traces of ammonia in the roots of oats (table 9).

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Table 9.

Contents of ammonium nitrogen and of nitrogen of certain amino acids in roots in milligrams N per 100 g of green weight of roots.

Water cultures.

Length of exposure of plants in hours	NH$_3$	Alanine	Dicarbonic amino acids	Asparagine
1	15.5	5.5	4.1	none
6	37.0	8.4	6.1	"
12	46.0	12.4	8.3	"
24	40.0	14.1	14.0	"
48	27.8	21.2	12.1	18.15
72	Traces	26.1	11.2	46.5

Evidently in the first hours after introduction of top dressing the roots of plants were not adapted to synthesis of large amounts of ammonia; later on though, all the ammonia, which entered the roots, was converted to amino acids and amides, as a result of the adjusting functions of a living organism. It is possible, that in this adaptation of plants to the synthesis of ammonia, an important role is played by the translocation of a certain amount of reserve proteins from the leaves into the roots of the plants.

In experiments conducted in 1954 with oats was studied the comparative speed of synthesis and of renewal of nitrogen of the amino acids (non-protein organic nitrogen), of constitutional and reserve proteins and of

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chlorophyll. For this purpose the experiment was conducted simultaneously in two series: 1) under normal light and, 2) in darkness. The blackout of the experimental plants in the second series was done by completely surrounding the vessels with plants by black cotton cloth. The experiment was done in water cultures. Ammonium sulfate with a fortyfold enrichment by N^{15} isotope was used as the tagged source of nitrogen. Such a high enrichment of the initial source of nitrogen permitted a very accurate evaluation of the contents of tagged nitrogen in fractions which were isolated from plants, even in those cases when the tagged nitrogen was included into the composition of the examined fraction in minute quantities; this, as a rule, is the case when plants are exposed to the tagged nitrogen for a short time. As in other experiments, which were examined in this article, the top dressing by tagged nitrogen was done in early stages of the plants' development, when they attained 25 days of growth. Conducting these experiments represented an interest from the point of view of establishing a (Begin p. 10) direct connection between processes of photosynthesis and of the formation of protein and of amino acids in green organs of the plants; many works, which were conducted in our country, as well as beyond our borders, are pointing this out* (1,2,5,6,7).

Table 10 gives data of yields and data of a chemical analysis of plants for both series of the experiment.

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Table 10.

Contents in plants (oats) of individual forms of nitrogen at different lengths of exposure to N^{15} in milligrams of N per 100 g of green weight of plants, in 1954.

Length of exposure of plants to N^{15} in hours	Green weight of plants in g	Non-protein organic nitrogen (amino acids)	Reserve proteins	Constitutional proteins	Chlorophyll
A. An experiment in normal light					
6	28.6	53.2	-	-	11.4
12	30.4	80.0	83.0	91.2	10.2
24	28.4	99.7	115.4	108.0	12.9
48	27.0	151.5	103.5	99.6	12.0
72	28.6	194.2	104.6	125.1	10.4
Control, without N^{15} top dressing	29.6	53.2	81.8	91.2	11.0
B. In darkness					
6	29.6	58.2	-	90.8	9.2
12	30.4	80.0	90.9	-	10.2
24	28.4	72.9	75.6	82.2	8.6
48	27.0	125.0	-	84.9	9.2
72	29.9	172.8	76.0	88.6	8.6
Control, without N^{15} top dressing	31.9	52.8	67.7	81.2	8.7

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There are not any regular changes in the contents in plants of protein nitrogen and of chlorophyll nitrogen which are determined by the length of exposure of plants to tagged nitrogen. There are but comparatively insignificant deviations toward one or the other side of the initial state of the plant. It is only for nitrogen of the constitutional proteins, at a 72-hour exposure of the plants to the tagged nitrogen, that a noticeable increase was detected. But the content of non-protein organic nitrogen (amino acid) increases continuously with the lengthening of exposure. No doubt the new synthesis of protein and chlorophyll in plants proceeded in the course of the entire experimental period, but the increase of these substances for a comparatively short time of the test was not sufficient to be evaluated by a chemical analysis. But between the series of the experiment with normal lighting and in darkness there are fully demonstrative distinctions. In plants which were kept in darkness, the content of all fractions of nitrogen was somewhat lower than in plants in the normal light. This gives certain foundation to think, that synthesis of all nitrogen organic compounds in plants in darkness proceeds slower than in the light.

Results of the isotope analysis of nitrogen fractions, isolated from plants in this experiment, are given in table 11.

Data of isotope analysis of individual fractions of nitrogen, which were isolated from plants grown in normal light, and which are shown in table 11, on the whole coincide well with results of experiments which were previously examined. The only thing that is new is the high enrich-

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ment by isotope N^{15} of all fractions of nitrogen; (sentence is continued on page 11, after table 11) (Begin p. 11)

Table 11.

Results of isotope analysis of individual fractions of nitrogen, isolated from the green mass of young plants of oats, in 1954.

Length of exposure of plants (40-fold enrichment with N^{15} in hours)	Enrichment with isotope N^{15}				% of renewed nitrogen		
	Organic non-protein	Constitutional protein	Reserve protein	Chlorophyll	Constitutional protein	Reserve protein	Chlorophyll
		A. An experiment in normal light					
6	4.01	1.37	1.21	1.59	12.2	7.0	19.8
12	4.06	1.67	1.48	1.79	21.9	15.6	26.2
24	8.18	2.49	2.30	3.09	20.8	18.2	29.1
48	16.40	8.72	4.50	7.10	50.2	22.7	39.7
72	19.61	-	7.89	-	-	37.0	-
		B. An experiment in darkness					
6	1.58	1.07	1.04	Not eval.	12.0	7.0	Not eval.
12	2.40	1.35	1.14	" "	26.0	10.0	" "
24	6.54	2.15	1.75	3.33	20.7	13.7	42.0
48	10.6	3.60	2.28	Not eval.	26.0	13.3	Not eval.
72	15.32	4.92	4.45	4.97	27.3	24.1	27.4

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this increases considerably the accuracy of the experiment and the authenticity of conclusions issuing from it (1).

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(1) The high enrichment by N^{15} isotopes of nitrogen fractions which were isolated from plants is conditioned by a correspondingly higher enrichment with N^{15} isotope of ammonium sulfate, which was used as top dressing.

The degree of enrichment by N^{15} isotope of all the fractions, isolated from plants, for all periods of exposure of plants to tagged nitrogen was much lower for plants which grew in darkness than for all the fractions of nitrogen in the experiment made in normal light. This, first of all, suggests, that the intensiveness of inflow of nitrogen into the plant depends on lighting conditions: with a deficiency of light the inflow of nitrogen into the plants falls off, and the rate of formation of amino acids in plants decreases. The tagged nitrogen, which enters the plants and is utilized for synthesis of amino acids, is also included into the chemical composition of proteins much slower in darkness, than in the light. On the whole the intensiveness of synthesis and of renewal of protein in plants is considerably lowered in darkness. Thus, light appears to be an important factor in nitrogen nutrition and metabolism of plants. Evidently synthesis of amino acids, and especially of protein in green plants, is directly linked to the photosynthetic process, but for establishment of causal connections between these processes much more research is needed.

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What concerns the influence of light conditions on the renewal of chlorophyll judging from the survey of the rate of renewal of nitrogen in chlorophyll by N^{15} isotope during two periods of exposure of plants to the tagged nitrogen top dressing, one can only ascertain that the renewal of nitrogen in chlorophyll proceeds in darkness also; but in what degree does the intensiveness of this process change, compared to plants growing in light, is impossible to judge from the sole data received in this experiment.

Conclusions

1. In plants a self-renewal of protein proceeds continuously. This process takes place with great intensity in above ground organs (Begin p. 12) (leaves) of young plants; in the course of 72-120 hours practically all nitrogen of the constitutional proteins is wholly renewed there.

2. The colloido-soluble reserve proteins of the green parts of plants are renewed much slower than the constitutional proteins. Tagged nitrogen is found in the composition of constitutional proteins in much earlier periods, than in the composition of reserve proteins, which gives a basis to assume, that the initial synthesis of protein starts with the formation of constitutional proteins.

3. The renewal of constitutional, as well as reserve proteins in the roots of plants, proceeds with a much smaller intensity, than in the leaves.

4. From the obtained data it is seen, that the mineral nitrogen which enters into the plants is very quickly utilized for synthesis of amino acids

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in the roots of plants. In any case, during experiments already in 2 hours after the introduction of tagged nitrogen top dressing it was possible to find a considerable amount of newly formed tagged amino acids. The introduced tagged nitrogen, as top dressing, was found in leaves of plants in 4 hours in the composition of amino acids, and in 6 hours in the chemical composition of protein and chlorophyll.

5. When tagged nitrogen top dressing was applied, the content of mobile, reserve proteins sharply increased in the roots at the expense of their outflow from the plant leaves. A supposition was expressed that the conversion of the inorganic nitrogen in the roots is carried out with the aid of reserve proteins, as bearers of specific enzyme systems which catalyze the synthesis of amino acids in plants. With an increased intake of inorganic nitrogen, the content of these proteins in roots becomes insufficient and the plants replenish this lack by translocating proteins from leaves into roots.

6. Lighting conditions play an important role in nitrogen nutrition and in metabolism in plants. Even during a short exposure of plants in darkness (for 6 hours) the inflow of nitrogen into the plant falls rapidly, with a simultaneous sharp reduction of intensity in amino acid synthesis. Intensiveness of the process of synthesis and renewal of protein also decreases in darkness.

7. Nitrogen of the pyrrole ring of chlorophyll is continually renewed. Intensity of renewal of the nitrogenous composition of chlorophyll is very high: in the conducted experiments nitrogen of the chlorophyll was approximately half renewed in the course of 36-48 hours.

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Gorbunov, N. I.

Glinistye minerały chernozemov, kashtanovikh i solontsovikh pochv.
[Clay minerals of Chernozem, Chestnut and Solonets soils]
Pochvovedenie, 11: 25-35, Nov., 1955. 57.8 P84
(In Russian)

Organic substances, in combination with mineral, are the cause of many physico-chemical properties of soils. The absorptive power, water permeability, swelling after moistening and shrinkage after drying, viscosity and tenacity depend on the amount, mineralogical and chemical composition of organic and mineral substances and on their interaction.

In the present article we are going to analyse the mineralogical composition of clay fractions (<0.001 mm) and its importance to the character of the soil.

In recent years studies of the mineralogical composition of the clay fraction of soils are getting greater attention; this is partly assisted by that circumstance, where science can now use such powerful methods as radiography, thermography, electron microscopy, and others.

Study of clay minerals in USSR is developing in three closely interlinked directions. First, the characteristics of the clay minerals and their importance to the fertility of different types of soil are studied; second, the mechanisms of formation and conversion of clay minerals are exposed, depending on the factors of weathering and soil formation and,

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finally, third, methods of isolation of clay minerals and their diagnosis have been improved.

We are going to consider the results of studies of clay minerals in chernozem, chestnut and solonets soils. These soils were studied in detail by G. M. Ponomarev and I. N. Antipov-Karataev (4) in their colloid-chemical aspect. Most of clay minerals, which are found in soils, can be joined into several groups, according to their characteristics. The most widespread among them is the montmorillonitic, which includes: montmorillonite, beidellite and nontronite. These minerals usually have a high degree of dispersion, a great capacity for cation absorption, they swell very much. Each of the minerals of this group has its peculiarities, which distinguish it by one or another feature from the others. For instance, nontronite contains a considerable amount of iron. The ratio $SiO_2:R_2O_3$ in these minerals is near two. Kaolinite has a smaller degree of dispersion and capacity for cation absorption compared to montmorillonite. Halloysite, in its turn, is usually more dispersed; than kaolinite, but in chemical composition differs little from kaolinite. To the third group belong hydro-micas (illite), which hold a position between the two cited groups of clay minerals in their degree of dispersion and in adsorptive volume.

The allophane mineral merits to be mentioned; often it is not detected during an analysis of the soil clay and of colloids by X-ray method on account of its amorphism. (Begin p. 27)

Somewhat apart among the clay minerals stand the minerals of sesquioxides: goethite, hydrargillite, boemite, and others, which are found in

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great numbers in krasnozems [red soils], in laterites and in illuvial horizons of some soils. The importance of these minerals is extremely great, as even in small quantity, they assist in texture formation of soils and in fixing the phosphates.

D. S. Beliankin has separated an independent mineral - monotharmite, which is sometimes referred to the group of hydro-micas or kaolinitic minerals.

We are not going to refer here to other clay minerals, or to primary minerals (micas, quarts), because they deserve a separate consideration.

In order to be able to judge the importance of the above cited clay minerals for soil characteristics let us turn to table 1.

It is possible to make several conclusions from data, given in table 1. First, some minerals and clays consist of clay (<0.001 mm) fractions and not of colloid. That is why the offer of some authors (Sedletskii, 5-6) to call the clay minerals colloidsdispersed has no basis. The colloid fraction (<0.5-0.2 u) comprises 22-52% only in montmorillonite clays. In kaolinites there are usually not more than 5-8% of the colloid size fractions.

Secondly, the clay minerals have a neutral or weakly-alkaline reaction. Opinions of some authors about a strict adaptation of minerals of the kaolinitic group to the acid medium, and of minerals in the montmorillonite group to a neutral and weakly alkaline medium, do not always correspond to reality.

Although a specimen of a white interlayer in krasnozems, cited in table 1, has an acid reaction, in this case the reaction appears to be a secondary

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phenomenon. The acid reaction was formed before the development of the white clay interlayer. This reaction assisted in the washing out of bases and of sesquioxides; and kaolinite, halloysite and hydrargillite remained on the place of formation. Formation of these minerals occurred as a result of weathering of feldspars in the presence of a weakly alkaline reaction; carbonates were accumulated simultaneously with this.

In dry climatic conditions the carbonates remain on the place of their formation with the minerals of the kaolinitic group. We noted such a combination of carbonates and kaolinite on eluvium of granite in the chernozem zone (near Dnepropetrovsk), in the semi-desert part of Azerbaijan, and in Central Asia.

The third conclusion concerns the capacity for cation absorption by the clays. Usually the capacity of absorption is measured in milliequivalents per 100 g of the object. We find it more expedient to refer the capacity to 100 g of the clay fraction (<0.001 mm).

From table 1 it is seen that the capacity of absorption of montmorillonite clays fluctuates in the limits of 74 to 112 m-eqv per 100 g of fraction <0.001 mm; in beidellite this value is somewhat smaller (55-65 m-eqv/100 g), than in other montmorillonitic clays. Minerals of the kaolinitic group have a capacity for cation absorption equal to only 15-24 m-eqv per 100 g of fraction <0.001 mm. Hydromicas have a slightly larger volume of absorption than kaolinite. Allophane's volume of absorption fluctuates in large limits - 20 to 60 m-eqv per 100 g of material.

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The degree of maximum hygroscopicity in clay minerals is an extremely important characteristic. It is known, that with this value it is possible to approximately calculate the content of moisture which is unavailable to the plants. In minerals of montmorillonitic group the maximum hygroscopicity is about 30%. In minerals of the kaolinitic group it is 5-6 times less than in montmorillonitic minerals. In the beidellite-like hydro-mica (illite) the maximum hygroscopicity is greater (the sentence is continued on page 30, after table 2) (Begin p. 28)

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Table 1.

Physico-chemical characteristics of clays

Names	pH (aqueous)	pH (salt)	fractions <0.001mm in %	fractions <0.2 u in %	capacity of absorption of fractions <0.001mm in m-eqv/100g	exchange capacity of the whole in m-eqv/100 g	maximum hygroscopicity in %	swelling in %	maximum molecular water capacity in %
Montmorillonitics:									
Askangel; "Anaseuli"	9.60-9.00	7.87-7.7	63.9-84.0	44.0	112.0-108.7	68.2-84.9	32.1	96.0	63.9
"Askanglina" [Askarclay] "Anaseuli"	5.56	4.75	42.38	-	74.0	62.7	33.0	53.3	60.7
"Kil krymskii" [Crimean clay]	7.78	6.08	42.3	34.2	86.0	55.5	-	52.2	50.87
Gilyalli; "Baku"	8.78	8.09	86.30	52.5	106.9	90.1	-	101.0	60.7
Gumbrin; "Batalsi"	6.45	5.62	46.4	22.9	102.2	56.7	30.6	38.2	48.4
Bentonite - "Oglanlinskii"	8.85	-	89.9	46.7	86.0	80.0	-	93.0	Not eval.
Beidellite (from the soil)	7.5	7.0	77.0	-	50.0-65.0	42.1	Not evaluated		
Kaolinitic, Halloysitics									
Kaolin "Eleninskii"	7.18	6.21	23.0	6.3	23.9	5.6	-	4.9	Not eval.
" "Mariupol'skii"	6.83	6.01	10-30.0	6.0	16.0	4.8	5.9	4.7	19.1
" "Glukhovetskii"	8.30	8.18	20.50	-	14.9	5.0	2.2	-	28.6
" "Balaiskii"	7.52	7.18	-	-	-	11.5	7.3	7.7	22.6
" "Glukhovskii"	-	-	84.3	-	20.34	9.0	-	-	Not eval.
Kaolin-halloysite interlayer in krasnozem	4.54	4.19	39.9	-	23.5	9.4	-	5.4	-
Halloysite with allophane	7.28	6.48	39.0	-	65.92	25.7	36.3	14.7	75.9
Halloysite No.20; "Tuchkovo"	7.40	6.92	13.1	-	39.0	37.8	27.0	8.2	47.7
Allophane artificial	-	-	-	-	-	20-80	-	-	Not eval.
Micas and Hydro-micas:									
Muscovite	7.52	7.44	-	-	Chang.	1.1	0.3	2.7	12.8
Beidellited hydro-mica (illite); "Sungait"	7.42	7.04	-	-	36.96	24.0	15.6	16.0	34.9
Beidellited hydro-mica in sediments of seas and soils	7.6	-	20.30	-	30.40	-	5.1	4.7	Not eval.
"Shira" (hydro-mica rock); "Azerbaidzhan"	8.4	-	68.6	5.0	37.4	24.0	-	17.0	Not eval.
Monothermitics:									
Monothermite; "Chasov-Iar"	8.04	7.64	72.0	1.5	-	13.2	13.7	17.0	28.1

(Begin p. 29)

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Table 2.

percent to a dried weighed portion

Soils	Depth from which specimen was taken in cm	Hygroscopic water in %	Loss on ignition in %	SiO_2	R_2O_3	Fe_2O_3	Al_2O_3	P_2O_5	MnO	CaO	MgO	K_2O	Na_2O	SO_3	$\frac{SiO_2}{R_2O_3}$	Fractions <0.001 mm in soil in %
Chernozem, southern on loess clayey soil; Rostov oblast; sect. 502	0-10	8.79	18.17	57.08	34.45	5.90	28.65	0.06	0.02	0.10	4.34	Un.*	Un.*	0.76	2.65	46.68
	75-85	14.17	17.07	53.91	41.98	12.06	29.92	0.24	T.*	0.51	2.53	"	"	0.58	2.45	45.10
	200-210	10.15	9.79	55.56	36.36	8.91	27.47	0.23	0.02	0.52	2.90	"	"	0.64	2.85	42.68
Chernozem, southern on red clay; MTS Rostov oblast'; sect. 504	0-10	8.08	15.57	53.18	39.60	15.21	24.47	0.19	0.08	0.17	3.92	"	"	0.82	2.62	30.84
	85-100	6.26	11.85	65.21	39.47	6.40	34.07	T.*	N.*	0.85	0.57	"	"	0.82	2.50	61.08
Chernozem, leached on loess clayey; Kamennaia steppe; sect. 77	0-16	8.00	25.04	56.14	34.22	12.29	21.01	0.57	0.08	2.29	4.01	3.01	0.20	Un.*	3.31	54.44
	60-65	7.80	13.40	55.98	36.31	12.98	22.49	0.22	T.*	0.93	3.90	2.50	0.07	"	3.09	56.22
	192-200	7.86	9.53	57.72	34.50	13.36	20.36	0.19	0.04	1.20	3.60	1.72	0.11	"	3.40	50.74
Chernozem, ordinary; Poltavskaia oblast'	5-25	7.70	17.78	57.72	35.20	11.09	24.11	0.41	0.05	N.*	2.52	3.06	N.*	0.12	3.14	16.80
	50-70	9.52	9.36	55.54	37.37	12.09	25.28	0.38	0.04	"	3.32	2.97	"	None	2.68	25.40
	110-150	10.18	9.84	56.62	36.71	11.89	24.82	0.35	0.03	"	3.29	2.10	"	T.*	2.96	27.60
Chernozem mountain on liparite, mountain "Zmeika"	10-20	5.99	10.36	43.98	49.77	13.08	36.69	0.60	Un.*	0.70	3.50	Un.*	Un.*	0.48	1.60	11.10
	0-5	6.47	30.54	53.15	41.11	18.15	24.98	Un.*	"	1.22	2.25	"	"	2.52	2.80	20.42
Chernozem on andesite-basalt tuff; Armenia; sect. 590-594	31-36	10.25	24.23	53.28	42.37	12.30	30.07	"	"	0.91	1.00	"	"	1.17	2.72	29.27
	96-101	8.71	14.17	56.04	40.64	14.14	26.50	"	"	1.08	1.68	"	"	1.78	2.65	11.56
Chernozem on diorite; Mar'ino, Crimea	Surface	11.65	10.66	47.58	41.70	18.05	23.65	0.34	"	2.01	7.29	"	"	0.76	2,30	30.00
Red soil on diorite; Partenit,	0-20	7.90	8.21	48.68	46.63	11.44	35.24	0.10	"	0.68	1.51	"	"	0.77	1.99	38.98
Chernozem on andesite-basalt tuff; lake Sevan; 1953	10-20	2.35	21.27	53.98	37.00	11.41	26.67	0.52	"	2.19	3.41	"	"	0.88	2.31	31.91

*Un - Undetermined
*T - Traces
*N - None

(Begin p. 30)

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(Begin p. 50) than in kaolinite and smaller than in montmorillonite. Swelling is especially sharp in montmorillonitic clays and weaker in kaolinitic.

Knowing physico-chemical characteristics of clay minerals and their quantity in the soils, one can have a fuller judgment about the characteristics of the latter.

For diagnosis of the clay minerals we utilized a number of methods: X-ray, thermal analysis, chemical analyses and sometimes electron microscopy.

In order to determine the clay minerals according to soil thermograms, we first of all obtained thermograms of minerals-standards. On fig. 1 are given thermograms (heating curves) of the predominant clay minerals, and on fig. 2 and 3 thermograms of fractions <0.001 mm, isolated from chernozems, chestnut and solonets soils.

Title of Fig. 1. Thermogram of secondary minerals. 1) Montmorillonite (ashanite. "Tsikhis-Ubani"); 2) beidellite; 3) halloysite (Zhuravlinskiy origin); 4) kaolin Glenlinskii; 5) hydro-mica (illite, Sumgaitskaia formation); 6) allophane Podmoskovnyi; 7) hydrargillite $Al_2O_3 \cdot 3H_2O$; 8) "boemite" according to Fedot'ev $Al_2O_3 \cdot H_2O$; 9) goethite $Fe_2O_3 \cdot H_2O$; 10) amorphous silicic acid $SiO_2 \cdot nH_2O$.

We took soils, which were formed on igneous and sedimentary rocks under different climatic conditions as objects for study. The fraction <0.001 mm was isolated by elutriation according to a method which is accepted by the X-ray laboratory of the Soil Institute AN USSR, from specimens of

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soil after kneading it into a state of thick, moist mass (2). After that the organic matter was burned out with the aid of hydrogen peroxide; following this the specimens were dried and placed into a desiccator for 5 days, in order to give them a certain moisture content. The thermoanalysis was conducted in the Kurnakov apparatus, the speed of heating equaled 11-12° per minute; maximum temperature for heating the specimens reached 1100°. Conditions of thermal analysis were similar everywhere.

Let us now proceed with interpretation of the thermograms of soil specimens by way of comparing them with thermograms of the standards and relying on data of chemical analyses (table 2).

In table 2 are given thermograms of soils (fraction <0.001 mm), which were formed on igneous basic (andesite-basalt), medium (diorite) and acid (liparite, granite) rocks. These rocks contain feldspars as predominant primary minerals, and besides that micas, pyroxenes, amphiboles, and some others. The secondary clay minerals were formed from the cited minerals.

The following conclusions can be made after deciphering the thermograms:

1. Kaolinite with a small admixture of beidellite and of minerals of sesquioxides are present in the mountainous chernozem (Kamika mountain). The presence of kaolinitic mineral group is revealed by the point of endothermic stop at temperature of 530° and by the exothermic stop at 920°, as well as the absence of endothermic stop at 805-850°, which happens in beidellite and illite. Endothermic stop at 90° points to the presence of hydrophilic minerals, for instance beidellite, and of amorphous substances;

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silicic acid, sesquioxides, and the like. A thermic effect at 270° points to the presence of minerals of sesquioxides.

2. Beidellite is present as the predominant clay mineral in the chernozem soil, on dicrite (Mar'ino village, near Simferopol'). (Begin p. 31) The presence of beidellite is disclosed by a large endothermic stop at 105°, endothermic stops at 525° and especially at 645°. A small stop at 275° testifies to the presence of minerals of sesquioxides.

3. Thermogram of the red soil on dicrite (Southern Crimea, Partenit) resembles the thermogram of the mountainous chernozem on liparite. Therefore, in this object the same minerals are present; kaolinite with an admixture of beidellite and of minerals of sesquioxides. The content of minerals of kaolinitic group is greater here.

4. In the mountainous chernozem on andesite-basalt tuff (Lake Sevan) beidellite predominates; also minerals of sesquioxides are present there.

5. In chestnut soil on eluvium of granite (Buryat-Mongolian ASSR; author N. A. Mogina) beidellite with an admixture of inert substances are present at a depth of 0-10 cm, also minerals of sesquioxides, and, possibly, kaolinite. At a depth of 20-30 cm beidellite is predominant.

Thus, one can take it as established, that from among primary minerals of igneous rocks beidellite, minerals of kaolinitic group and of sesquioxides can be formed. Predominance of one or another mineral in the soil depends on many factors. Minerals of kaolinitic group are formed either on rocks, which yield easily to weathering (basalt), or under conditions of a more moist and warm climate (Southern Crimea, Partenit), where there

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are conditions for washing out of the more dispersed mineral - beidellite, and accumulation of the less dispersed minerals of the kaolinitic group.

Title of Fig. 8. Thermograms of fractions <0.001 mm, isolated from chernozems and chestnut soils, formed on eluvium of igneous rocks (from top to bottom)- 1) mountainous chernozem on liparite, Zmeika mountain, Piatigorsk; 2) chernozem soil on diorite, Mar'ino village, Crimea; 3)"Molkozem" (soil, in which particles are smaller than 0,25 mm) of red soil on diorite in Partenit, Southern Crimea; 4) mountainous chernozem on andesite-basalt tuff, Lake Sevan; 5,6 - section 539. Chestnut soil on eluvium of granite. Buryat-Mongolian ASSR (author N.A. Mogina).

Let us now turn to interpretation of thermograms of chernozems, of chestnut and solonets soils on igneous rocks (Fig. 8). We see that almost all thermograms are similar to the standard thermogram for beidellite. Minerals of the kaolinitic group are also present as a small admixture. Thermogram of the chernozem, which was formed on Paleogene clay (sect. 504, by N. A. Shurygin) and on solonets meadow soil (sect. 21) make an exception to this.

The large size endothermic stops at 560-575° in section 504 and near 615° in solonets - section 21, and exothermic at 915-970°, as well as the sharp forms of thermic curves show the predominance of minerals of kaolinitic group in these specimens. Beidellite is present in a small amount. One should suppose, that the predominance of kaolinite in chernozem on Paleogene clay is not of recent soil formation, but is indebted to the conditions of formation of clayey minerals in remote past.

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(Begin p. 32)

Title of Fig. 8. Thermograms of fractions <0.001 mm, isolated from chernozems, chestnut and solonets soils. 1) Sect. 502. Southern chernozem, changing to ordinary on loess clayey soil of Rostovskaia oblast'; 2) Sect. 504. Southern chernozem on red clay (Paleogene), Rostovskaia oblast'; 3) Sect. 77. Ordinary chernozem on a deposit of clay, Krasnodar steppe; 4) Ordinary chernozem, Poltavskaia oblast' (the word, in thermogram 4, means loess); 5) Section 62. Ordinary chernozem on yellow-brown deposit of clayey soil; 6) Sect. 24. Southern chernozem of loess yellow-brown clays, village Novosel'e, Crimea; 7) Sect. 25. Light-chestnut soil, Stavropol'skii krai; 8) Section 184. Steppe solonets on Sarmatian clay, Crimea; 9) Sect. 21. Meadow solonets (becoming eluviated), Rostov-on-Don.

One should mention, that on many cited thermograms (Fig. 3) there are present small endothermic steps at 250-300°, showing the presence of minerals of sesquioxides, which are especially great in section 77 at a depth of 8-16 cm.

Thus, beidellite and minerals of kaolinitic group can be present in the chernozems and chestnut soils. Depending on the rock, climatic situation, and biochemical conditions in the soil either minerals will predominate. We received similar results also when studying krasnozems and podzolic soils (8). It is interesting to note that we did not find any montmorillonite in any of the soils. With the aid of radiographic analyses it is hard to distinguish montmorillonite from beidellite, but the thermal curves for the cited minerals differ from one another (fig. 1). Resting on data of thermal,

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chemical and physical-chemical analyses we came (Begin p. 88) to conclusion, that in clay fractions of soils beidellite is often found but not montmorillonite, as some researchers think. However, one should take into consideration the closeness of characteristics of montmorillonite and of beidellite. M. F. Vikulova and V. B. Zviagin separate beidellite from montmorillonite in a special group of minerals (1); Grimm (7) denies the existence of beidellite and acknowledges only montmorillonite. Regardless of the solution of this disputed problem, one can assume that beidellite and montmorillonite are formed from feldspars, micas and other minerals as a result of weathering, and also, possibly, as a result of synthesis of products of decomposition of primary aluminosilicates. During such a decomposition of kaolinite, in the opinion of V. I. Vernadskii, a residual mineral is formed whose origin exists in feldspars.

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Table 3.

X-ray data of fraction <0.001 mm, isolated from chernozem and solonetz.

Chernozem; section 504; depth 95-100 cm		Chernozem; sect. 502; depth 75-85 cm		Solonetz on Sarmatian clay; sect. 184; depth 95-100 cm	
d	I	d	I	d	I
11.56	5 dif.	9.79	5 dif.	9.79	5 dif.
9.79	-	-	-	-	-
7.05	8	-	-	-	9 -
4.40	5	4.40	9	4.40	-
3.88	8	-	-	-	-
3.61	9	-	- -	-	-
3.30	4	3.32	9	3.32	9
2.81	2	2.81	1 dif.	2.81	1 dif.
2.56	7	2.55	9	2.56	9
2.48	7	-	-	2.39	1
2.34	9	-	-	-	-
-	-	2.12	9 dif.	2.12	7
1.99	1	-	-	-	- -
1.81	1	1.82	2	-	-
1.69	5 dif.	1.72	6 dif.	1.71	1 dif.
1.61	6	1.68	-	1.66	6
-	-	1.54	2	-	-
1.49	9	1.51	9	1.51	9
1.29	2	1.38	2	1.30	6 dif.

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On the basis of the above-cited assumptions and experimental data it can be said, that in chernozem, in chestnut and solonets soils the minerals of montmorillonite group cannot be guaranteed to be present, and that the formation of one or the other mineral has no direct connection with the reaction of the environment, as it was supposed by I. D. Sedletskii (5,6). We think that the formation of secondary minerals depends on a series of factors, which are common with factors of soil formation.

The presence in chernozems of minerals of montmorillonitic and kaolinitic groups is ascertained by data of radiographic researches. As an example let us cite the interplane distances and intensity of the lines, which were obtained for fractions <0.001 mm, isolated from specimens (table 5). In two cited specimens (sect. 502 and 104) we found lines which are characteristic for beidellite (d=4.4;2.5; 1.68;1.51) and in one (sect. 504) we found lines, which are characteristic for minerals of kaolinitic group (d=7.05;3.51; 2.48;2.34).

Besides this, the X-ray data helped us to discover highly-dispersed quartz (d=3.34; 2.12 and others) and a small number (sentence is continued on page 35, after table 4) Begin p. 34

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Table 4.

Physico-chemical characteristics of chernozems, chestnut and solonetz soils

Soil	Depth from which specimens were obtained in cm	pH (aqueous)	pH KCl (salt)	Content of fractions <0.001mm	Volume of absorption of fractions <0.001mm in m-eqv per 100 g	Volume of absorption in the whole in m-eqv per 100 g	Clay minerals in the fraction <0.001 mm
Chernozem southern on loess clayey soil; Millerovo, Rostov oblast; sect. 502	75-85	6.6	6.6	45.1	51.13	18.51	Beidellite predominates; admixture of sesquioxides.
Chernozem south. on Paleogene clay; Millerovo, Rostov oblast'; sect. 504	0-10	Undeterm.	6.1	50.84	Undeterm.	27.3	Minerals of kaolinitic group predominate; beidellite and minerals of sesquioxides are pres.
	95-100	7.80	6.20	61.08	27.5	Undeterm.	
	140-150	7.40	6.00	6.46	23.30	3.1	Same as above
	50-520	Not evaluated		52.7	21.64	8.1	Same as above
Chernozem ordinary; Kamennaia steppe; sect. 77 (10)	192-200	8.5	-	50.74	60.07	30.41	Beidellite predominates; minerals of sesquioxides are also present.
Chernozem on liparite; Zmeika mountain, Piatigorsk	10-20	5.93	5.2	11.10	37.4	4.1	Minerals of kaolinitic group mixed with minerals of sesquioxides; beidellite presence is also possible
Chernozem on andesite-basalt tuff; Sevan	10-20	6.73	5.93	31.91	70.87	21.96	Beidellite predominates; minerals of sesquioxides are present.
Ureruozem Kubanskii; K.K. Gedroits	80-100	-	-	65.0	67.5	43.87	Not evaluated
Solonetz on Sarmatian clay Crimea	90-100	7.30	6.36	77.1	54.67	42.1	Beidellite predominates; minerals of sesquioxides are present.
Chestnut soils on eluvium of granite; Buryat-Mongolia; sect. 593	0-10	7.39	6.54	15.2	-	18.2	Same as above and a considerable amount of inert substances.
	10-20	7.35	6.61	7.7	-	18.4	
	42-49	7.32	6.48	4.0	-	12.0	
Red soil on diorite; Partenit, Southern Crimea	Exp.	-	6.31	38.9	36.6	15.8	Minerals of kaolinitic group predominate; mixed with beid. and sesquiox.
Chernozem on diorite, Marino, Crimea	10-50	6.86	6,29	30.0	63.0	21.1	Beid. predominates, minerals of sesqui. present

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of micas, which we could not find by a thermal method, in view of an insufficient sensitivity of this method.

In conclusion we shall cite a table of some physico-chemical characteristics of the examined samples and compare them with data of contents of the clay fraction (<0.001 mm) in soils and their mineralogical composition (table 4).

The above cited data show that in soils, which contain mostly beidellite, the exchange capacity and the maximum hygroscopicity is larger than in soils containing the kaolinitic group of minerals. In some soils the exchange capacity is dependent on the mixture of kaolinite and beidellite and with highly-dispersed minerals of a type of allophane and halloysite. Incomplete dispersion causes the presence of the volume of dispersion in fractions which are larger than 0.001 m. Unfortunately we cannot determine allophane by thermic or radiographic methods, and we can only indirectly judge of its presence by the high exchange capacity of those objects which have a thermogram similar to a thermogram of a mixture of kaolinite with hydrophilic substances, that is they have a notable thermic stop at temperature 80-150° and pointed, big stops at 500-550° and 900-1000°.

Determination of halloysite by thermic method is also hampered because of the resemblance of its thermogram with a thermogram of a mixture of kaolinite with any hydrophilic substance, including amorphous silicic acid and sesquioxides. On a halloysite radiogram usually there are lines which are common to kaolinite and beidellite. Specific line 10.0 often blends with the background.

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Conclusions

1. Clay minerals condition the physical-chemical characteristics of soils. That is why it is possible to foretell many of their properties by the mineralogical composition of clay fractions of soils.

2. Mineral formation depends on many factors. There is no direct dependence between the formation of clay minerals and the reaction of the medium (pH), although one should not deny the influence of the reaction of medium.

3. Beidellite or minerals of kaolinitic group, or mixture of the above cited minerals, depending on factors of weathering and soil formation: rock, climate, biological processes, age of the soil, and others, are present in fractions <0.001 mm of chernozem, chestnut and solonets soils. Montmorillonite was not detected in these soils as a predominant mineral. Minerals of sesquioxides can be present as an admixture to clay minerals in many soils.

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Gureev, I. G.

Dvoinye mezhlinejnye gibridy kukuruzy VIR-25 i VIR-42 v Moldavii.

[Double interlinear maize hybrids VIR-25 and VIR-42 in Moldavia (from experience of kolkhozes and scientific-research institutions).]

In Kishinevskii Sel'skokhoziaistvennyi Institut imeni M. V. Frunze. Sbornik rabot po izucheniiu kukuruzy v Moldavii. pp. 212-228. Moskva, Sovetskaia Nauka, 1955. 59.22 K64

(In Russian)

During the last five-year plan scientific institutions of Moldavia have developed, tested and distributed on kolkhozes about ten different intervarietal hybrids most of which produce a 1--4 centners per hectare increase in yield compared with the regionalized foundation variety of Dnepropetrovskaia. The best hybrids, however, under Moldavian conditions proved to be the double interlinear hybrids of VIR-25 and VIR-42 which produce a stable 6--10 and more centners per hectare increase in yield, compared with local regionalized varieties and hybrids, as indicated by data cited below (tables 1, 2 and 3).

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Table 1.

Average grain yield of maize VIR-25 and VIR-42, compared with the standard regionalized variety of Dnepropetrovskaia for 1952-1953 in different zones of the Moldavian SSR

(As per data of the State Commission for Variety Testing (5))

No. in cons. ord.	Natural zones of the republic	Number of test plots conducting tests	Average grain yield (in c/ha for 1952-1953--		
			Dnepro-petrov-skaia	VIR-25	VIR-42
1	Forest-steppe	3	25.4	34.3	38.2
2	Steppe, transitional	3	25.8	33.7	36.3
3	Steppe, southern	4	27.6	34.9	37.2
4	Central tree-overgrown "Kodry"	2	30.7	39.7	41.7

Double interlinear hybrids surpass the productivity of other local varieties even more conspicuously. Thus, in the dry year of 1953, the following results were obtained during variety testing at the experimental selection base of the Kishinev Agricultural Institute:

	Grain yield	
	in c/ha	in %
Dnepropetrovskaia (standard).....	20.8	100
Double interlinear hybrid VIR-42.....	29.0	142
Moldavanka sheltaia.....	18.2	89
Moldavanka oranzhevaia.....	16.7	82
Polusubovidnaia mestnaia.....	16.6	81
Portokaliu.....	11.6	57

A stable surplus in the productivity of hybrids VIR-25 and VIR-42 over that of the basic regionalized Dnepropetrovskaia variety is visible also from data of variety testing cited in table 2.

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Table 2.

Yield of double interlinear maize hybrids VIR-25 and VIR-42 compared with the regionalized foundation Dnepropetrovskaia variety, as per data of test plots in the Moldavian SSR for 1952, 1953 and 1954 (in centners per ha of grain with 14% moisture)

Name of test plot	1952			1953			1954		
	Dnepro-petrovskaia	VIR-25	VIR-42	Dnepro-petrovskaia	VIR-25	VIR-42	Dnepro-petrovskaia	VIR-25	VIR-42
Oknita	34.6	45.4	47.3	25.6	35.7	36.4	4.6	11.3	10.5
Lyonita	31.2	45.6	50.4	18.2	28.8	28.3	5.8	7.6	6.7
Tiraspol'sk	30.2	39.6	42.2	16.4	22.0	23.7	1.9	2.3	2.1
Balmaklisk	39.0	45.3	50.7	29.0	42.0	41.7	16.9	22.6	19.6
Tarakliisk	29.0	27.0	38.2	27.4	34.6	36.4	24.0	29.6	26.7
Kalarash	28.7	34.0	39.5	26.3	36.3	34.3	17.3	26.0	22.9
Kishinev	38.5	47.6	54.9	27.9	40.3	38.0	15.8	22.2	19.3
Zgurita	25.0	25.9	36.9	19.4	24.3	27.6	4.4	9.7	8.9
Average surplus of double hybrid productivity over that of Dnepropetrovskaia (centners per ha)	-	6.0	15.0	-	9.6	9.9	-	5.4	3.4

In the same test years intervarietal hybrids gave a small and unstable productivity surplus over that of the Dnepropetrovskaia variety-- up to 1--4 centners per hectare, or their yield equalled that of Dnepropetrovskaia.

Under the unfavorable conditions of 1954 all hybrids and varieties suf-

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fered heavily from drought and produced a low yield. Hence, the absolute yield surplus of hybrids VIR-25 and VIR-42 over Dnepropetrovskaia on test plots in 1954 was less in centners than in preceding years. Nonetheless, the superiority of double interlinear hybrids was not shaken even in 1954.

In the year 1954 the hybrid VIR-42 suffered more from drought than did VIR-25. This can be explained by the length of the vegetative period: VIR-25 ripens 6-7 days earlier than Dnepropetrovskaia, while VIR-42 ripens 1-3 days later than Dnepropetrovskaia, hence the drought of the second half of the 1954 summer affected it worse. In this particular year the very early-ripe varieties excelled in productivity in general, for instance, Bukovinka-2 and Kichkasskaia, because they had almost completed the ripening process of grain before the drought became severe.

In normal years, however, the early-ripe varieties lag in productivity far behind Dnepropetrovskaia and even more so behind the double interlinear hybrids VIR-25 and VIR-42.

If all kolkhozes of the Republic were basically (up to 80-85%) changed over to growing maize from the hybrid seed of VIR-25 and VIR-42, then the total yield of grain, even on the former cropping areas, would increase by more than 5 million centners, and on every kolkhoz by an average 3-3.5 thousand centners.

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Table 5.

Yield of hybrid VIR-25 and VIR-42 maize grown by participants of the Moldavian Republic's agricultural exhibition of the year 1954

	Name of kolkhoz and district	Name of leading participant of agr. exhibition	Name of hybrid	Yield in c per ha	Area cropped in ha
1	K-z "Krasnaia Pobeda", Lepkanskii District	Brig. Kochetkov	VIR-25	38	14
2	K-z im.Molotova (village Sofiia), Bel'tsy District	Brig. Edu	VIR-25	25	160
		Brig. Bobir	VIR-42	30	60
3	K-z im. Zhdanova, Bel'tsy District	Zven. [group member] Bazian	VIR-42	40	30
4	K-z im. Lenina, Tyrnov District	Brig. Syrdyniuk	VIR-25	30	90
		Zven. Tsaralunga	VIR-25	36	14
5	K-z im. Stalina, Tyrnov District	Zven. Russu	VIR-25	38	17
6	K-z "Biruintsa", Tyrnov District	Zven. Kirillov	VIR-25	35	16
7	K-z im. Voroshilova, Tyrnov District	Brig. Bursuk	VIR-25	35	50
		Zven. Kukushan	VIR-25	37	15
8	K-z "Bol'shevik", Tyrnov District	Brig. Varvariuk	VIR-25	35	83
		Zven. Ungurian	VIR-25	360	15
9	K-z "Stiagul Roshu", Tyrnov District	Zven. Katrar'	VIR-25	36	15
		Zven. Furtuna	VIR-25	37	15

For instance, the kolkhoz im. Zhdanov, Bel'tsy District, was the first one in the Republic to begin using the double interlinear hybrids VIR-25 and VIR-42 and as a result obtained over 3 thousand centners of additional yield of maize grain as early as 1952. Since 1955 this kolkhoz has changed over to planting maize almost exclusively with double interlinear hybrids and to growing its own seed. Even in the very unfavorable year of 1954 the

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I. G. Bazien group gathered VIR-42 maize at the rate of 40 centners each from 50 ha.

In 1954, 72% of the participants in the Republic's agricultural exhibition of maize obtained a high yield from hybrid crops, 53% among them obtained high yields from double VIR hybrids. Maize yields of VIR-25 and VIR-42 grown by participants of the Republic's agricultural exhibition are cited in table 3, regardless of the 1954 bad drought.

For their high productivity and adequate drought resistance the double interlinear VIR-25 and VIR-42 hybrids have been certified among the best in varietal regionalization by the Moldavian SSR, VIR-25 since 1953 and VIR-42 since 1954.

In 1954 the Republic's kolkhozes had cropped more than 62 thousand hectares to hybrid seed (18% of all crops), this number included 10.4 thousand hectares cropped to VIR-25 and VIR-42, and 5 thousand hectares to their parent forms.

To accomplish the tasks set by the Party and the Government for a sharp increase in grain production, the Republic has made arrangements for all kolkhozes and MTS [machine-tractor-stations], beginning with the year 1955, and concomitantly with other important measures, to start sowing maize with seed of the first generation double interlinear hybrids VIR-25 and VIR-42.

SYSTEM FOR GROWING SEED OF VIR-25 AND VIR- 42 HYBRIDS

To use hybridization to better advantage it is necessary to establish a system of seed growing that will ensure a yearly production of maize crops grown over the entire projected area from seed of double interlinear hybrids

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in the first, most productive generation, and will permit to create emergency stocks and the necessary seed reserves.

The use of second generation seed of the double interlinear hybrids VIR-25 and VIR-42 is permissible in exceptional cases temporarily, so long as there is not enough first generation seed, and on condition that the second generation seed be gathered from a highly productive plot.

The seed of simple interlinear hybrids can, however, be used to create double hybrids, also temporarily, in the first as well as in the second and even in the third generations. In the future the seed of simple hybrids as well should be utilized only in the first generation.

The seed growing system used in the Republic can fully provide kolkhozes with seed of the parent forms of the VIR-25 and VIR-42 hybrids. All that is needed is clear, systematic work to be done by all seed growing groups called upon to perform the planned tasks of the Ministry of agriculture, Moldavian SSR, for the cultivation of these hybrids.

The State Selection Station, however, together with the elitkhozes [kolkhozes growing elite seed] had made no provisions in Moldavia for the production of the required amount of good seed from simple maize hybrids of the first and second generations; many district seed kolkhozes together with workers of MTS and centers of "Zagotzerno" [seed preparation] have violated the rules governing propagation, treatment, drying and storing of hybrid maize seed; the seed of hybrids VIR-25 and VIR-42 which received wide distribution were not those of the first, most productive generation, but those of the third, fourth and subsequent generations; this resulted

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in a sharp decrease of the effectiveness of hybrid seed material [gibridnykh posevov] and in a number of kolkhozes it simply imperiled this important measure.

The existing Moldavian system of seed growing used to produce hybrid seed of VIR-25 and VIR-42 can be explained by the following scheme:

State Selection Station	"Zagotzerno" [Seed Preparation Center]
Growing self-pollinated lines of the first and second generations of simple interlinear hybrids.	Preparation and release of seed of simple and double interlinear hybrids.
Elitkhozy (Oknits and Tiraspol'sk [kolkhozes growing elite seed])	
Growing seed of the first and second generations of simple interlinear hybrids.	Same
District Seed Kolkhozes	
Propagation of seed of simple interlinear hybrids.	Same
Kolkhozes and Sovkhozes	
1. Growing their own seed of double interlinear hybrids on hybridization plots.	Same
2. Seed of first generation of double interlinear hybrids sown on farms.	

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The Moldavian State Selection Station (City of Bel'tsy) together with the elite seed growing farms (Oknitza and Tiraspol'sk), which work under its direction, have a commitment to grow every year self-pollinated lines and first and second generation simple interlinear hybrids:

a) Iskra (26 x 27)[1], which is the maternal form, and Ideal (28 x 29) - the paternal form of the double interlinear hybrid VIR-25 [Begin p. 217]

b) Slava (44 x 58) - the maternal form and Svetoch (40 x 43) - the paternal form of the double interlinear hybrid VIR-42.

The planned order [plan-zakaz] given to the State Selection Station and the elitkhozes to grow any kind of correlation of different lines and simple hybrids is determined annually by the Ministry of Agriculture of the Moldavian SSR. The seed that has been grown is turned over to "Zagotzerno" by the State Selection [Station] and the elitkhozes at the established increased prices and compensations.

From "Zagotzerno" the seed of simple interlinear hybrids are sent by order of the Ministry of Agriculture, Moldavian SSR, to the district seed kolkhozes for further propagation; from there they are delivered to "Zagotzerno" in the second and third generations at the established increased prices and compensations.

The plan to propagate seed of simple hybrids determined by the Ministry of Agriculture, Moldavian SSR, is calculated to supply annually the demands of all kolkhozes and sovkhozes in the Republic for seed to be used to grow interlinear hybrid seed on hybridization plots.

1 The figures in parentheses indicate the numbers of the original self-pollinated lines from which the simple hybrid was derived.

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Provisions are made also for the necessary reserves and emergency stocks.

Kolkhozes and sovkhozes are getting from "Zagotzerno" centers seed of simple interlinear hybrids of the second and third generations and are growing from these double interlinear hybrids of VIR-25 or VIR-42 on their own hybridization plots, depending on the established hybridization plan. To develop the first generation of VIR-25 the simple hybrids of Iskra (maternal) and Ideal (paternal) are used.

To create the first generation of VIR-42 the simple hybrids of Slava (maternal) and Svetoch (paternal) are sown on the hybridization plots.

Each farm prepares its hybridization plots calculated to meet fully its own needs in first generation hybrid seed to be used for farm sowing as well as for the establishment of an emergency stock at the approximate rate of 5-6 ha to every 100 ha of farm planting. From the first generation double hybrid seed grown the kolkhoz keeps the amount needed for its own next year's sowing and for an emergency stock. The surplus of hybrid seed is turned over to "Zagotzerno". Upon presentation of the varietal documents the kolkhoz is paid for these seeds a higher price and the corresponding compensation.

GROWING HYBRID SEED ON KOLKHOZES

Leading kolkhozes use the following agrotechnics to grow hybrid maize seed.

Plots for growing hybrid seed are set aside on one of the crop rotation fields together with other crops which require interrow tillage, or on a non-rotation field, [Begin p. 218] for instance, on an area assigned to orchards

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and vineyards, but still unused. A distance of not less than 200 m from other maize crops is obligatory, so that pollen of other maize varieties and hybrids may not be carried in at the time of flowering.

The hybridization plot is selected on an even area with the most fertile soil which has definitely been plowed in the fall. Fertilizer is applied at the rate of 10-15 tons of manure and 2-3 centners of superphosphate per hectare during fall plowing; wherever fertilizers have not been applied in the fall, they must be applied during spring tillage at the rate of 2-3 tons of humus and 2-3 centners of superphosphate per ha. If humus is unavailable then mineral fertilizers alone can be applied; superphosphate at the rate of 2-3 centners and ammonium sulfate at 1.5 centners, or ashes at the rate of 5-7 centners per ha.

In early spring, just as soon as the soil stops being pasty, moisture must be conserved by dragging (shleifovaniem] or by harrowing. Later it is cultivated at a depth of up to 12 cm and then harrowed. Before seeding time one more cultivation is carried out, and if there appear many shoots of weeds in the field, then a third cultivation is carried out at the depth where the seeds are to be buried before seeding takes place.

Seed must definitely be disinfected before they are sown with a granosan and benzene hexachloride [geksakhloran] mixture at the rate of 1 kg of granosan and 2 kg of benzene hexachloride per ton of grain. Disinfection safeguards the seed against mold and infection by corn smut [Ustilago zeae], as well as against injury by wireworms and rodents.

Seeding is accomplished when the soil becomes quite warm, up to 10-12° C

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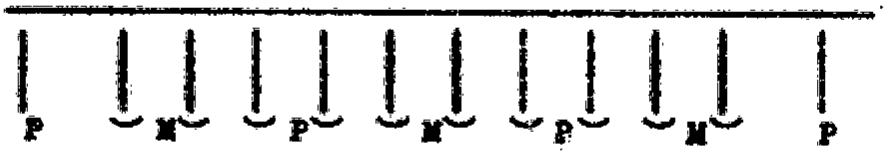
at a depth of 10 cm.

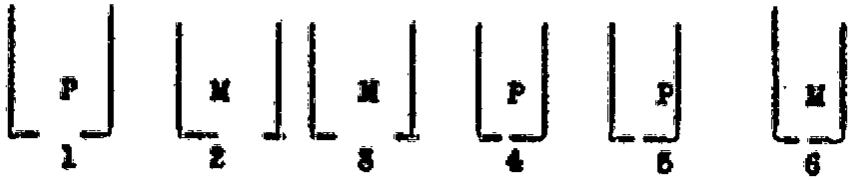
In the southern districts of the Republic this occurs more frequently from the 11th through the 20th of April, and in the northern districts--from the 21st through the 30th of April. The seeds are embedded in the moist layer of the soil at 8-10 cm; on light and insufficiently moist soils--up to 12 cm.

Seeding is carried out by following a marked course, in a strictly straight line, definitely by the hill-check method, with the seeder SSh-6A (SKO-6) with a measuring wire and a 70 x 70 cm space between hills, dropping 3-4 grains in each hill. The rate of seed consumption per hectare, depending on the size of the seed, is approximately: for hybrid Lukra 18-20 kg, and for other interlinear hybrids 20-25 kg.

For the convenience of subsequent tearing off of tassels of maternal plants, it is recommended to alternate maternal and paternal rows at two rows each instead of one row according to the following scheme:



To accomplish this with the six row SSH-6A seeder, the first, fourth and fifth seed boxes (counting from the left if one stands behind the seeder) should be filled with seed of the paternal form, and the second, third and sixth - with seed of the maternal form according to the following scheme:



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To keep workers from mixing up the parent forms while adding seed, it is recommended that every seed box on the seeder be labeled: "Maternal" or "Paternal".

For the purpose of increasing the output of hybrid seed per hectare on the hybridisation plot, the Ukrainian Scientific-Research Institute of Grain Economy (Dnepropetrovsk) recommends seeding two rows of maternal plants to one row of paternal.

(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)
(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)
(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)
(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)	(•)	(‡)	(•)
M	P	M	M	P	M	M	P	M	M	P	M

(•) One plant in hill (‡) Two plants in hill

Depending on weather conditions, Moldavian kolkhozes are using any kind of scheme, provided the young crops are ensured excellent care and complete pollination of maternal plants by the pollen of paternal plants.

To avoid mistaking rows while tassels are being torn off, a small amount of sunflower seed (100-150 grams per hectare ratio of maize planting material) is mixed with the seed of the paternal form; the sprouts of these will serve as a criterion in identifying the paternal rows. When maize is thinned the sunflower plants are left standing after every 10-15 m.

Care of the young crop on hybridisation plots is of the same type as for young crops in general. Thinning is carried out at the stage of 3-4 leaflets with 2 plants left in the hill. In the case of a dry summer it is recommended

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to carry out one more thinning, leaving in the maternal rows one plant per hill, and in the paternal ones 2 plants. Enlargement of the nutrient area guarantees a stable yield even in a dry summer and increases the output of large, well developed ears of the hybrid.

During the summer aeration of interrows is carried out in two directions not less than three times, and hand weeding of hills not less than 2-3 times. [Begin p. 220]

The first mechanized tillage is done across the young crop before thinning. The first two cross-cultivations are carried out at a depth of 10-12 cm, the subsequent ones up to 8 cm. The yield and the quality of hybrid seed depend on the cleanliness and friability of the soil.

It is recommended that two supplementary feedings of the young crop be carried out with nitrogenous phosphate [fosforno-azotnymi] fertilisers. The first time - immediately after thinning, the second time - before projection of tassels.

It is necessary to examine and to remove systematically parts of plants infected by smut, or the whole plant if infection is heavy, and it then should be burned or buried on the edge of the field at a depth of not less than 50 cm.

Suckers on maternal plants must certainly be removed, but on paternal plants they may be left so as to have more pollen to fertilise with maternal plants.

The most responsible instance is the timely and careful breaking off of tassels of maternal plants before they flower so as to prevent pollination

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of female blossoms (silk) on the ears of maternal plants with pollen of its own kind, i.e. of the maternal variety.

Yield and other properties of simple as well as of double hybrids depend first and foremost on timely breaking off of maternal tassels and, apart from that, on good agrotechnics, supplementary artificial pollination, drying and correct storage of seed. This should always be remembered and agrotechnical requirements should be strictly observed.

Tassels must be broken off when they begin to emerge from the funnel shaped opening of the upper leaf on separate plants and in no case during their flowering season. Besides the fact that a delay in breaking off tassels may spoil hybridization, they [the tassels] consume plastic substances and thus weaken the plant. In view of the fact that all tassels are not projected at the same time, their breaking off must be continued daily until they are plucked from all maternal plants; suckers must also be removed for they, too, are capable of forming tassels. This work and the checking thereafter are continued daily for approximately 15-20 days.

In growing seed of the VIR-25 double hybrid, tassels appear first on the maternal simple hybrid Iskra. This helps to identify rows. In addition, the leaves of the hybrid Iskra are colored a light-green while those of the paternal simple hybrid Ideal are dark-green; it projects its tassels 3-5 days later than the hybrid Iskra.

In the parent forms of the VIR-42 double hybrid, however, the maternal form (Slava) has dark-green leaves, and the paternal form (Svetoch) light-green.

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Before proceeding to break off tassels the group leader instructs once more the members of his group, shows them the technique of breaking and assigns them to rows. A workman goes between two neighboring maternal rows, [Begin p. 221] grabs the tassel which shows from the funnel-like opening of the upper leaf in his fist and tears it off with a sharp upward jerk together with the pedicel (frequently also with one leaflet). There is no need to refrain from tearing off one upper leaflet; this guarantees that the whole tassel has been torn off, for if it is torn off without the leaflet there sometimes remain a few tassel branches which later on produce pollen and thus spoil the purity of hybridization, reducing the quality of hybrid seed. It is, however, in no case permissible to tear off two or more upper leaves, since this weakens badly the plant.

The tassels and suckers which have been torn off must be removed from the field and fed to cattle. Torn-off tassels left in the field may sometimes complete their ripening process and their pollen is likely to pollinate the silk of ears.

In the season of mass flowering of the ears of maternal plants, supplementary artificial pollination with pollen from paternal plants should be carried out during the morning hours; this will increase the productivity and improve the varietal properties of hybrid seed.

HARVESTING, DRYING AND STORING OF HYBRID SEED

Maize harvesting on hybridization plots must be carried out when ripening has been completed, when the grain has turned hard and acquired the lustre typical of a given hybrid. Harvest must be accomplished rapidly within a short space of time, remembering that procrastination may cause

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the ears to become moist due to autumn rains and thus lead to infection by fungus diseases. Damp ears do not keep well and their seed lose their germination capacity.

Harvesting is done by hand by breaking off the ears and simultaneously removing their husks [obertka]. First, the ears of the maternal plants, which form the most valuable hybrid seed material of the first generation, must be gathered and transported from the field to a place where they are sorted and dried.

When the ears in the rows of maternal plants have been gathered, then the harvest of the paternal forms takes place; all steps must be taken to keep them during their harvest, transportation and storage from contaminating the hybrid seed grown. The parent form is usually utilized for farm purposes, but if the need arises it may serve another year for hybridisation, with the permission of the head agronomist of the MTS.

Immediately after their harvest hybrid ears are carefully sorted; all unripe and disease infected ears and atypical admixtures are removed, and the ears are cleaned of the silk which has remained on them. Ears which have sparse grain, or are small but ripe and healthy may be left for seed, since they also possess high productivity.

Following the sorting it is essential to dry seed-grain ear by taking advantage of warm, sunny days, but in a damp fall drying must absolutely be conducted in rooms equipped for it. [Begin p. 222].

Moisture in seed-grain ears must be brought down to normal - not above 14-16% - before frost sets in. It must be kept in mind that increased moisture

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reduces the germination capacity of maize seed, at a 10° frost and grain moisture above 16% germination decreases sharply, and at 17° it is almost completely lost.

After the ears have been dried they are sorted once more and a storehouse is approved; then they are kept until spring in a dry, well ventilated room absolutely separate from other maize batches. During their storage precautionary measures against their contamination by other varieties and hybrids must be strictly observed.

During the fall and winter the condition of the ears and their moisture is watched, germination of seed is checked and measures eliminating storage shortcomings are taken in good time.

REGISTRATION AND CERTIFICATION

In obtaining seed material of parent forms for hybridization or seed of the ready double interlinear hybrids of VIR-25 and VIR-42 (as well as of any other hybrids), it is necessary to ask the "Zagotzerno" Center or the farm releasing hybrid seed for a certificate indicating their origin, generation, properties and other data. The certificate is kept the same as other important documents in the bookkeeping department of the kolkhoz.

Field inspection is not performed on hybridization plots, and the registration agronomist [agronom-aprobator] conducts a field inspection, pursuant to the established method, only after the tassels have been broken off.

Here the quality of tassel breaking is checked.

The inspector selects 10 spots diagonally on the plot and at each spot examines 50 maternal plants one after the other to ascertain whether all tassels

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had been broken off and no separate little branches had been left. The registration agronomist compiles the results of the field inspection on the established form.

If two inspections disclose that more than 5% of the tassels had not been torn off before flowering began, then the question of the feasibility of using the seed material from that plot is settled by the Ministry of Agriculture of the Moldavian SSR.

On district seed kolkhozes and on other farms where parent forms are propagated field registration is conducted in accordance with the existing method of certification of varietal seed-grain of maize.

Young crops sown for farm use from hybrid seed are not certified, but, as variety crops, they are subject to registration indicating which generation of hybrid seed had been used in planting. [Begin p. 225]

After the yield has been gathered and the ears have been sorted then the warehouse certification of hybrid seed and of the seed of parent forms is accomplished in accordance with the instruction determined for the certification of variety seed-grain.

In field certification the seed of simple interlinear parent hybrids must be at least 99.8% true to their varietal type and must not contain more than 100 xenial grains on 100 ears, and after sorting they must be 100 percent true to their variety type and must not have more than 10 xenial grains on 100 ears.

For hybrid seed of the first generation a certificate is issued in accordance with the established form. For seed of the parent forms of hybrids, the usual certificate or a varietal confirmation.

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The quality of seed is checked in the seed control laboratory which issues the appropriate authentication.

On the basis of the original documents (field inspection act or certification, warehouse certification act and authentication of seed quality) the farm which has grown the hybrid maize seed issues a separate variety certificate with every batch of seed released in accordance with the existing form.

Variety confirmation is a fundamental document which confirms the variety and the seed properties of hybrids; it must be kept in the bookkeeping department of the kolkhoz the same as other important documents.

BRIEF DESCRIPTION OF THE DOUBLE INTERLINEAR HYBRIDS
VIR-25 AND VIR-42 AND THEIR PARENT FORMS

Simple interlinear hybrid Iskra (26 x 27). It was obtained by crossing the self-pollinated lines No. 26 (maternal) and No. 27 (paternal). It is used as the maternal form in growing the double hybrid VIR-25. It has a white dent grain with a smooth pit, slightly oval and of average size; the weight per 1000 grains is 200-250 gr. The ear is of average size, its average weight is 150 gr., it is slightly cone-shaped, more often of a cylindrical form. The stem of the ear is white in all generations. Grain output 82%. Average height of plant 180-200 cm. It is slightly bushy, leaves light green. Lodging tendency slight. The hybrid ripens early and produces an average yield.

Simple interlinear hybrid Ideal (28 x 29). Obtained by crossing the self-pollinated lines No. 28 (maternal) and No. 29 (paternal). It is used as the paternal form in growing the double hybrid VIR-25.

The grain is white, dent-shaped with an elongated, strongly wrinkled

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pit, it is flat, large, and has a large embryo. The average weight of 1000 grains is 300 gr. The ear is large, thick, cylindrically shaped, average weight 200-250 gr. In the first and second generations the stem of the ear is red, in the third and subsequent generations - red and white. Grain output 82-83%.

The average height of the plant is 160-200 cm. It is slightly bushy. Its leaves are dark green. It does not lodge. It is almost resistant to common smut [Ustilago zeae], [Begin p. 224] but becomes infected by head smut [Sphacelotheca reiliana]. Hence planting after maize, or alongside of a field cropped a year ago to maize should be avoided. It ripens 7-10 days later than the Iskra hybrid. It produces a high yield and is very drought resistant. Grain and stem moisture increases during the harvesting season, therefore drying of ears is essential.

Double interlinear hybrid VIR-25. This hybrid is obtained by crossing two simple interlinear hybrids; the maternal form is the hybrid Iskra (26 x 27), and the paternal - the hybrid Ideal (28 x 29). Its grain is dent-shaped, white comparatively large, slightly elongated, average weight per 1000 grains is 250-300 gr.

The ear is comparatively large, average weight 150-200 gr. It has 14-16 rows of grains. Fifty percent of the plants have a white stem and 50% a red one; some years there occurs a deviation in either one or the other direction. The output of grain is 82-84%; it is distinguished by an increased starch content. Its infection by common smut [Ustilago zeae] is negligible. The full-grown plant measures 175-200 cm. It is slightly

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bushy. Lodging tendency average. The hybrid is drought resistant, medium-early-ripening, matures 5-7 days earlier than Dnepropetrovskaia, it is an adequate predecessor for winter crops. It produces a high yield, surpasses Dnepropetrovskaia by 7-10 or more centners per hectare.

Simple interlinear hybrid Slava (44 x 58). This hybrid serves as the maternal form in growing the double hybrid VIR-42. Its grain is dent-shaped, bright-yellow, with a wrinkled pit, it is elongated and more narrow than that in the hybrid Svetoch, it is large, 1000 grains weight 280-300 gr. The stem of the ear is red in all generations. The ears are large, cylindrically shaped, and are well filled out with grain. Rows of grain are straight, the furrows between them are narrow. The average weight of the ear in the first generation reaches 220 gr. Grain output is 80%.

The plant is vigorous and well developed, its stems at the base are thick, sturdy and do not lodge. There are practically no fruitless plants. The leaves are wide and dark green. The plants reach a height of up to 200 cm. It does not branch out and is medium ripening; it flowers and matures 5-7 days earlier than the hybrid Svetoch. It is rarely infected by common or head smut, and it is drought resistant. In the first generation it produces a high yield.

Simple interlinear hybrid Svetoch (40 x 45). This hybrid serves as the paternal form in growing the double hybrid VIR-42. Its grain is dent-shaped, yellow with a smooth or slightly wrinkled pit, it is wide with a large embryo, often light-colored at the top. Weight per 1000 grains is 285-300 gr. In the first and second generations the stem of the ear is red,

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in the third and subsequent generations - red and white. The ears are large, cylindrically shaped, well filled out with grain. Average weight - 150-200 gr. The furrows between grain rows are narrow, infrequently - average. Rows of grain are straight and tapered. [Begin p. 225].

The plant is vigorous and well developed; stems at the base are thick and sturdy, they do not lodge. Leaves are wide and light-green. The average height of the plant is 180 cm. It does not branch out. The hybrid is late-ripening, it flowers and matures 5-7 days later than the hybrid Slava. It is almost unsusceptible to common and head smuts. It is highly productive.

Double interlinear hybrid VIR-42. This hybrid is obtained by crossing the simple hybrids Slava (maternal) and Svetoch (paternal). Back crossing is not excluded: Svetoch (maternal) and Slava (paternal).

The grain is dent-shaped, yellow and elongated. Weight per 1000 grain is 250-300 gr.

The ears are large, cylindrical, well filled out with grain, 14-16 rows. Furrows between grain row are narrow; the rows are basically straight. The stem of the ear is red. Average weight of the ear is 150-200 gr. Grain output 80-83%.

The plant is vigorous and well developed. The stems at the base are thick, sturdy, and do not lodge; if, however, harvesting is delayed, then stem fragility is observed. Leaves are wide and intensely dark green. The height of the plants is 180-200 cm. It does not branch out. It is medium ripening and matures 1-3 days later than Dnepropetrovskaia. It is comparatively drought resistant and is not susceptible to common or head smut. There are very few fruitless plants. It is highly productive

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hybrid and holds first place among the cultivated varieties and hybrids of Moldavia, with the exception of the 1954 drought when it fell behind the early-ripening varieties of Bukovinka - 2, Kishkaeskaia and others, and the hybrid VIR-25, but produced a higher yield than the Dnepropetrovskaia variety and the local intervarietal hybrids.

ORGANIZATION AND DIRECTION OF GROWING HYBRID SEED ON KOLKHOZES

In accomplishing successfully the production of hybrid seed and their wide-spread adaptation to farm sowing, timely performance of organizational measures in the MTS zone and on every kolkhoz, and the systematic guidance of the work on part of MTS agronomists is of great significance.

MTS agronomists must assist kolkhozes in working out measures needed to begin growing maize from seed of the double interlinear hybrids of VIR-25 and VIR-42, and coordinate the measures as a whole in the MTS zone, especially for the propagation of parent forms, for their supply and interchange between seed of first generation double hybrids.

The kolkhoz agronomist must select correctly the hybridization plots, must organize field work in good time and must personally watch the progress and quality of the work and inspect the finished work of the working groups. [Begin p. 226]

Just as soon as plowing is begun the hybridization plots must be assigned to special seed growing groups and their management must be entrusted to experienced kolkhozniks, preferably to some of those who have been graduated from or are attending the three-year agrozootechnical courses at the kolkhoz.

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The work load imposed on a group must be such as to permit all work, particularly the tearing off of tassels, to be accomplished within agrotechnical time and qualitatively on a high level, at the approximate rate of not more than 1-1.5 hectares per group member.

In winter time group members should be given agrotechnical instruction in growing hybrid seed, and in the summer time they should be taught practical methods, with their work being strictly supervised.

The rates of production and remuneration for work done on hybridization plots, particularly at breaking off tassels, should be determined by kolkhoz managements taking into consideration the specially high demands made upon quality and time in the fulfilment of the work, and also the strain caused by the exactness involved in it. A somewhat higher remuneration for work involving higher requirements on hybridization plots will be repaid many times over by the increased productivity of maize obtained from properly grown hybrid seed.

To stimulate superior quality in hybridization work the kolkhoz management, apart from the general supplementary pay, should establish a system of supplementary pay for work of kolkhozniks who grow hybrid seed in accordance with the increased productivity of maize sown from these seed in farm planting.

Head agronomists of MTS should personally, and also through agronomists servicing kolkhozes, guide, direct and supervise the execution of adopted measures and agrotechnics used in growing hybrid seed and in the adaptation of planting the double interlinear hybrids VIR-25 and VIR-42 and other highly productive varieties and hybrids.

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CONCLUSION

In conjunction with other highly important means - adequate preparation of seedbed and seed, timely hill-check planting, good care, application of fertilizers and combatting losses - the transition to planting maize with seed of the first generation double interlinear hybrids VIR-25 and VIR-42 will prove one of the firm foundations in increasing within the next 2 years the total maize harvest in Moldavia at least by twice.

It is necessary to call to the attention of kolkhoz managements, brigadiers, and agronomists servicing kolkhozes that double interlinear hybrids produce the highest and most stable increase in yield in the first generation, in the second generation the increase in yield drops by almost twice, and in subsequent generations even lower. [Begin p. 227] Hence, hybridization plots should be prepared every year so as to grow yearly new seed of double hybrids ensuring a sharp increase in productivity.

Non-observance of this important rule led in 1954 on some kolkhozes of the Rybnitsa, Orgeev, Kangaz and other districts to low yields of the hybrids VIR-25 and VIR-42 which had been seeded from seed of the 3rd, 4th and later generations, and thus undeservedly imperiled these most valuable hybrids.

The behavior of simple intervarietal hybrids is somewhat different; these can be propagated for a number of generations, and with proper expert selection it is possible to derive from them highly productive varieties of hybrid origin. Thus were created "Partizanka" by Mark Ozernyi, "Odesskaia 10" by the Vsesoiuznyi Selektsionno-Geneticheskii Institut im. T.D. Lysenko, the hybrid "Kishinevskii-2" KSKHI [Kishinev Agricultural Institute] and others.

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However, as has been indicated above, double interlinear hybrids deserve special attention for their high grain productivity which surpasses the yields of other regionalized varieties and hybrids. Hence the double interlinear hybrids of VIR-25 and VIR-42 must be adapted to production more rapidly and more widely, and the methods of their seed growing must not be confused with the seed growing of simple intervarietal hybrids.

It is, naturally, understood that in the first years, when there is a shortage of the seed of first generation hybrids VIR-25 and VIR-42, second generation seed selected from highly productive plots can be utilized. The change in favor of seeding first generation seed exclusively must, however, be accomplished more rapidly.

Other high-grade selection varieties and hybrids, local as well as those imported from neighboring Odessa and Chernovitsa Regions, which have given a good account of themselves for their high productivity, must also be utilized. Of such varieties the hybrid variety Odesskaia 10, which has proved especially productive as to grain and silage mass, deserves widespread adaptation. In the southern regions this variety produces up to 400-600 centners per hectare of silage mass, and on some farms of Podmoskov'e [vicinity of Moscow] up to 900-1000 centners. The grain of this variety ripens later than that of Dnepropetrovskaia. Some kolkhozes of Moldavia cropped in 1954 small test plots to the Odesskaia 10 variety and obtained a high yield. For example, the kolkhoz im. T.D. Lysenko, Tyrnov District, gathered more than 50 centners of ears from one half of a hectare. The V.I. Cherednik group on the kolkhoz im. Bulganin, Slobodzeisk District,

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grew from this variety 50 centners per hectare of grain on the ears and 700 centners [per hectare] of green mass for silage.

Others deserving of attention are the early-ripening variety of Bukovinka - 2 and Kichkasskaia which, under conditions of the 1954 drought, came out first in productivity in Moldavian variety tests because they successfully completed the ripening process of grain before the drought was at its height, while other varieties were only in the ripening stage and were badly affected by the drought. [Begin p. 228] In normal years, however, the early-ripening varieties cannot compete with the double hybrids VIR-25 and VIR-42 and other highly productive hybrids and varieties.

The simple intervarietal hybrid Kishinevskii--2 KSKHI developed under the direction of Professor Kovarskii proved excellent. Thanks to correct selection, this hybrid gave a yield on the im. Lenin kolkhoz, Chadyr-Lunga District, at the rate of 30-33 centners per hectare of grain on an area exceeding 100 ha, even in the fifth generation.

In 1952 this maize variety yielded 30.4 centners per hectare of grain on an area of 1147 ha.

Right now all available ways and means must be applied extensively in order to achieve a sharp rise in the productivity of maize and, particularly, to grow seed of the first generation hybrids VIR-25 and VIR-42 for their wide-spread adaptation to production.

Agronomists of MTS and kolkhozes must themselves completely master this business and must teach the kolkhoz masses the technics of hybridization, and instil in them an interest for this important measure.

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The measures for increasing maize productivity are in our hands. They should be applied with determination and systematically organized.

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Trans. A-731
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Klinkovskii M., and Keler, G.

Perspektivy primeneniia antibiotikov v praktike zashchity rastenii.

[Outlook in the utilization of antibiotics in the practice of plant protection.]

Zhurnal Obshchei Biologii, vol. 17, no.3, pp. 169-184, May-June, 1956.
442.8 Z6

(In Russian)

East Germany

Formation of antibiotics - is a phenomenon which is widely spread in nature; it can be assumed to be natural to all living organisms. Secretion of antibiotics is of great importance in the life of lower organisms, but, apparently, in higher plants they also play an important role.

Antibiosis, in contrast to symbiosis, is understood to be an activity of specific substances, secreted by some organisms and producing on other organisms a depressing or fatal action. Definition of this product of exchange by the word "antibiotic" is not wisely chosen, because one does not speak here at all about substances which suppress life. Names "prosimbiotik" or "antisimbiotik" were offered instead. But the name "antibiotic" has already taken root as a conception, and changing it may lead to confusion.

Derenberg (1950) has offered the following definition of the antibiotic idea: 1) an antibiotic represents a product of metabolism even in that case when this substance was already previously obtained by synthetic means; 2) an antibiotic produces an antagonistic influence

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on the development of one or several forms of microorganisms, and 3) an antibiotic is effective even in exceptionally low concentrations.

A definition of the "antibiotic" idea was offered by Wakeman and his co-workers in 1942, and supplemented by Wakeman in 1951. According to his definition an antibiotic is a chemical substance, secreted by microorganisms having an ability even in a diluted solution to depress the growth of bacteria and destroy them. At present one can add, that antibiotics can be obtained synthetically.

What importance do antibiotics have in nature? English and American authors lean to an opinion that functions of antibiotics in nature are very limited. But this point of view aroused some objections. Thus, Winter and Willeke (1951) proved by experiments, that the inhibitors of microbic origin can eliminate in natural soils a development of a large number of soil microorganisms. Time and again one meets advocates of a point of view that antibiotics are a means of self-assertion in the struggle for existence. But this is contradicted by the fact that the effectiveness of antibiotics is always limited by a few forms. One should also note the easiness with which microorganisms get adjusted to these "poisons" to the great regret of doctors and workers in pharmaceutical industry. According to research by Virtanen (1953) formation of penicillin in Penicillium notatum should not be taken as a process that renders a poison harmless or as a protective action against other microorganisms, but this statement still needs further proofs. Taking into consideration our present day knowledge, one can say, that antibiotics can under certain (Begin p. 170) conditions help in the struggle for

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existence. To what extent this does characterize their true function can only be decided by further research.

Many attempts were made to systematize antibiotics and coordinate their effectiveness with their chemical structure. Yet until the present time, it was not possible to establish general rules of this type. Most diverse chemical compounds occur among antibiotics, and it is not always easy to point to those groups of molecules in an antibiotic which specify its biological action.

It is possible to establish the general properties of antibiotics by subdividing them according to types of organisms from which they were isolated. Thus, antibiotics of fungous origin represent compounds with a low molecular weight; for the most part they are soluble in organic solvents, and often they have an acid reaction, seldom a neutral one. A series of antibiotics, secreted by actinomycetes, on the contrary, represent organic bases. Antibiotics, formed by bacteria, often are substances which are moderately soluble in organic solvents and have a dipole character of polypeptides. Dependence of the chemical nature of antibiotics on the characteristics of those forms which secrete them is conditioned by fundamental differences in the metabolism of various groups of organisms.

We know antibiotics which originate from bacteria, fungi and actinomycetes. We know that the green seaweed Chlorella and the simplest Paramaecium aurelia form penicillin. A presence of antibiotics was also found in many lichens. According to research by Dold (Dold and Deck, 1941), a human organism also has antibiotics which are characteristic to him and

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are called inhibins. Secretions, which are discharged externally, tears, saliva, nasal liquid, milk and urea - have a strong antibacterial action.

Antibiotics occupy a firm stand in medicine and veterinary science. Of late they also began to be used for the control of plant disease. This is one of the few examples, when similar therapy can be used in medicine and in plant protection. There is no wonder in such a parallelism, as the phenomenon of antibiosis has been long known in the protection of plants.

* * *

Let us first of all look into the problem of organic fertilizers from the point of view of antibiotics. From practical experience it is known that green manure can prevent illness (for instance, in case of the pathogen of potato scab Streptomyces scabies).

Thom and Morrow (1936) have proved that organic substances during a period of their decomposition in the soil effectively retard or suppress the development of pathogenic fungi. It was ascertained, that an addition of glucose or other carbohydrates produces a favorable influence on the antagonistical action of organic fertilizers. It has been long known that biological interrelation in the soil can be changed by introduction of organic fertilizers, which influence the number of microorganisms. The growth of microorganisms which generate antagonistic substances against specific organisms, which are pathogenic for the plants is apparently stimulated by fertilizing, that is by an introduction of carbohydrates. G rossbard (1953, 1954) succeeded to prove that many standard generators

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of antibiotics are able to secrete biologically active substances in the soil after straw fertilization. During many years of cultivation of one crop on the same section, there occurs a propagation of organisms, which cause root disease. Organic fertilizing first of all favors the growth of soil esprophytes, which dislodge the pathogenic forms.

A question arises, if it would be possible to fight certain pathogenic organisms by means of inoculation of the soil by antagonists. Anwar (1949) succeeded by way of addition of Bacillus subtilis to prevent any disease in barley, which was infected by Helmintho-sporium sativum. Weindling and Fawcett (1936) have proved that the infection of citrus plants by rhizoctonia can be substantially reduced with an introduction (Begin p. 171) of trichoderma into the soil. Van Luijk (1938) informs about the effectiveness of Penicillium expansum when alfalfa and other grain grasses are affected by Pythium. Expansin (Natura and col., 1946), an antibiotic which is secreted here is identical to substances which were described by other authors under the name of patulin, clavatin, clavacin, claviformin. This antibiotic is secreted besides Penicillium expansum, also by P. patulum, P. claviforme, P. urticae, Aspergillus clavatus, A. giganteus, A. terreus, and others.

A fungus Trichoderma lignorum can be called an antagonist in regard to some soil parasites. This fungus together with a formation of antibiotics, "gluitokein" [glutoxin] and viridin is also capable of active attack, and it can destroy myceliums of certain parasites, for instance: Rhizoctonia and Pythium. At that time it entwines the mycelium of the parasite with a spiral; in other cases the mycelium after dying can be

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broken down under the influence of the cited antibiotics. (Weindling, 1932, 1934.)

A number of similar examples could be considerably increased.

At the present time a wide factual material has been collected about the means of control of plant disease, based on microbe antagonism. Nevertheless these methods do not always give positive results. The problem is to change from empirical researches to a true scientific knowledge and on this basis achieve practical results.

* * *

At the beginning of the forties, experimentations with penicillin, and later with streptomycin, in phytopatology were entered in with indecision. On the basis of experience, which was collected by medicine, antibiotics should first of all be tested against bacterial pathogenic organisms. The fact that we had fungicides, insecticides, rodenticides and herbicides was also a stimulus, but the bactericides were not yet known to phytopatology.

In 1944 and 1945 Brown and Boyle reported about a successful control of the pathogen of root canker (Agrobacterium tumefaciens) by means of penicillin. A repeated verification of this data by Stapp (1951) gave a negative result. Yet the research of the cited authors helped in a more detailed study of these questions and served in their time as an inducing reason for including these problems into the working program of the Institute of Phytopatology in Aschersleben.

The negative result which was obtained by Stapp is not surprising

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now, because Agrobacterium tumefaciens is gram-negative, and penicillin, as it is known, reacts only on gram-positive bacteria. Streptomycin, which also reacts to gram-negative bacteria gives better results in the contest with A. tumefaciens. I t is also possible to use aureomycin when it is absorbed by the roots (Blanchard, 1951).

Streptomycin ,which is formed by actinomycetes, was tested against many phytopathogenic bacteria and in many cases gave positive results. Brown and Heep (1946) succeeded in the control of the pathogen of bacteriosis of stone fruits (Xanthomonas pruni) by plunging infected young plants of Prunus forms into antibiotic solutions. Ark (1947) disinfected with streptomycin a cucumber seed material which was infected by Pseudomonas lachrymans. The antibiotic could be found two months later in embryos of treated seeds. Ban Schaak (1948) conducted a successful control of the pathogen of bacterial ring rot (Corynebacterium sepedonicum) in vitro and in vivo. Now we know representatives of genera Erwinia, Xanthomonas, Corynebacterium, Pseudomonas and Agrobacterium, in whose control the use of streptomycin gave successful results. Tomato seeds, which are infected by a pathogen of bacterial withering (Corynebacterium michiganense),* CAN BE DISINFECTED BY A MOIST TREATMENT IN ANTIBIOTICS. It is possible to prevent bacterial growth, producing leaf spot in tomatoes (Pseudomonas tomato),* IF THe infection occurs after spraying the tomatoes by antibiotics.

In U.S.A. antibiotics are being used in fruit growing much more widely. In 1954 Taubitz reported about Mernik's experiments in the

* The letters should be in lower case.

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control of pathogen of bacterial burn (Erwinia amylovora), a bacteriosis of fruit trees; the Old World has long been afraid that it might be brought over there. Three sprayings of apple trees by streptomycin and terramycin (= agrimycin) were conducted during field tests. The sprayings were done shortly before the beginning of blooming, that is the opening of flower buds, during full bloomin g and at the time of falling off of petals. The trees, which were treated with antibiotics, were not affected by any disease during the whole vegetative period.

Agrimycin (mixture of 10 parts of streptomycin with one part of terramycin) is especially important in the fight with bacteriosis of plants. Although the appearance of pathogenic organisms, which are resistant to antibiotics, is not yet known in phytopatology, the addition of terramycin to streptomycin was done to prevent such an occurence. From medical experience (Begin p. 172) it is known how fast those forms arise, which are resistant to streptomycin. Although terramycin is less effective than streptomycin, it, nevertheless, prevents the appearance of resistant forms (Dunegan a. col., 1954).

In USSR Mirzabekian has proved in laboratory experiments, that antibiotics, obtained from actinomycetes, are able to suppress the following pathogens: Bacterium armeniaca, a pathogen of bacterial wilt on apricot trees, Xanthomonas malvacearum, a pathogen of cotton gummosis, and Pseudomonas syringae, a pathogen of "mal'sekko" [malsecco] of the citrus trees.

TITLE OF FIGURE ONE - Bean Plants:

a - control; b - experiment. Treatment of seeds against bacterial leaf spot (pathogen Pseudomonas phaseolicola)

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(Figure Continued)

with culture fluid Striptomyces. sp. and planting on April 23, photograph taken May 21, 1954. Experiment in flats in a hothouse.

In experiments with apricot wildings it was discovered that treatment with antibiotics gave good results only when it was well timed after infection. In field experiments it was possible to prevent further spreading of the infectious wilting in apricots by treating the infected trees. The treated trees developed normally, although somewhat slower. When treating cotton seeds by immersion antibiotics penetrate into all the parts of the embryo, preventing the initial infection. During necrosis of citrus trees success was obtained in preventing the fruits from infection by means of a prededing treatment with antibiotics. (Begin p. 173)

One should mention that Darpoux and Faivre-Amiot (1948) report about a successful disinfection of tobacco seeds, infected by Pseudomonas tabaci. Heggested and Clayton (1954) received better results from treatments with streptomycin (from 200 to 400 parts per million) than with Bordeaux solution.

In central Germany beans are cultivated on large areas; the yielding capacity of beans is decreased by bacterial spot, caused by Pseudomonas phaseolicola. Which can be transferred through seeds. We set up an experiment with nonpurified penicillin (300 internat. units) and nonpurified streptomycin (80 internat. units) which we received. The bean seeds were disinfected or immersed in appropriate culture filtrates (for 30, 60, or 120 minutes). Evaluation was conducted in 3 weeks after planting (Fig. 1). In hothouse experiments 22 varieties of beans were tested.

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In experiments of the first year it was found out that with the initial material, which already lost its germination ability by 38%, it was possible to obtain a large increase in percentage of healthy seeds with the use of both antibiotics. Field experiments with 21 varieties (length of treatment 2 hours) gave the same results.

These experiments show, that seed material which was infected by bacterial spot can be disinfected by antibiotics. Success of disinfection was obvious when the number of sick and healthy plants on experimental and control sections were compared (tables 1 and 2).

Table One

Influence of preplanting treatment of bean seeds with antibiotics on the infection of plants by Pseudomonas phaseolicola

(Average data of experiment in a hothouse with 22 varieties. Evaluation was done 3 weeks after planting, in per cent.)

	HEALTHY	SICK	DID NOT GERMINATE
CONTROL	. . . 30	32	38
PENICILLIN 1/2 hour .	. . . 67	14	19
" 1 hour .	. . . 75	1	24
" 2 hours	. . . 75	0.3	24.7
STREPTOMYCIN 1/2 hour . .	. . . 74	7	19
" 1 hour . .	. . . 76	0.3	23.7
" 2 hours .	. . . 80	0.3	19.7

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Table Two

Influence of preplanting treatment of bean seeds with antibiotics on the infection of plants by Pseudomonas phaseolicola (Average data of field experiments with 21 varieties, in per cent.)

	HEALTHY	SICK	DID NOT GERMINATE
CONTROL	46	35	19
PENICILLIN	87	0.2	12.8
STREPTOMYCIN	92	0.1	7.9

Regular treatment of bean seed material for large areas would eliminate initial nidi of infection and considerably decrease a danger of lower yields (Klinkowski, 1951).

There is no doubt that antibiotics can be used as bactericides, and their utilization really brings recovery.

A question arises if it is possible to control fungi diseases by means of antibiotic disinfection. It is necessary to verify if it is possible to use antibiotics of fungicidal action for disinfecting seeds of grain crops, of sugar beets and others.

Experiments, which were conducted in our Institute by T. Gerstner were concerned with control of wheat smut (Tilletia tritici). Data of table 3 show that culture filtrates of different fungi of genus Penicillium are not less effective than a mercury preparation, germisan, and even surpass it. But the use of antibiotics produces a substantial injury to

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the germ. Nevertheless, there are such antibiotics which, without damaging the germs, considerably lower the disease or even fully suppress the infection. (Begin p. 174)

On the basis of our experiments we think that such antagonistst can be found which will combine high antibiotic effectiveness with a weak phytotoxic action.

Table Three

Effictiveness of treatment of wheat seeds to control wheat smut (Tolletia tritici). Disinfected by a culture filtrate on 16, III, 1953; planted into the field 20 III, 1953. (Mean data of 4 replications.)

DISINFECTANT	% of GERMINATION	% of INFECTION
PENICILLIUM 12/a	68	3.6
PENICILLIUM 12/b	62	0
" 16	62	0.22
" 21	76	5.65
" 24	56	0.39
" 25	62	0.0
" 26	47	0.0
" 27	70	0.17
" 28	53	0.7
" 29	62	0.47
GERMISAN	87	3.6
UNTREATED	89	31.3

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Table Four

Disinfected spores of the wheat smut (Tilletia tritici) where applied to the earth surface in cups.

FILLER	CULTURE FILTRATE (PENICILLIUM, STRAIN 6)	WITHOUT CULTURE FILTRATE
SILICIC ACID	2-3*	4
KIESELGUHR	1	2-3
SCHISTOSE (or shale)meal	2	3
KAOLIN	1	4
$CaCO_3$	2	4
WITHOUT FILLER	0	4

* Degree of infection: 0 - without germination; 1 - single coronate bodies; 2 - coronate bodies evenly but thinly distributed; 3 - numerous coronate bodies; 4 - very dense distribution of coronate bodies.

In order to substitute moist disinfection by a dry one, different fillers were tested for their influence on the process of disinfection with the addition and without the addition of the culture filtrate (Table Four). The protective action of the filler for the spores should be related to antibiotics which were absorbed by the fillers. It is necessary to make further research before making a decision about the possibility and form for conducting of dry disinfection with the aid of

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antibiotics. According to data of field experiments (table 5) Kaolin might be the most suitable filler. Our experiments, as well as experiments of other authors, have proved that it is possible to successfully control the wheat smut (Tilletia tritici)with the use of antibiotics. Further experiments must decide the question if it is possible to control the pathogen of the streaky spot of barley (Helminthosporium gramineum) (table 6).

Table Five

Influence of dry disinfection of spring wheat on the infection by Tilletia tritici planted in a field on 8. IV. 1953.

FILLER and CULTURE FILTRATE (PENICILLIUM, STRAIN 9)	% OF INFECTION
SILICIC ACID	16
KIESELGUHR	14.5
SHALY MEAL	16
KAOLIN	3.6
$CaCO_3$	7.4
INFECTED, BUT NOT DISINFECTED	16

Experiments of 1953 have shown a distinct effect produced by disinfection with antibiotics compared to the untreated control; yet, it did not achieve the effectiveness of mercuric preparations. In experiments of 1954 (sentence continuesson p. 175 after table 6).

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Table Six

Influence of disinfection of barley for the control of Helminthosporium gramineum. (Mean data for 4 replications.)

FILLER	% of GERMINATIONS	% of INFECTION	FILLER	% of GERMINATIONS	% of INFECTION
DISINFECTED BY CULTURE FILTRATE: ON 17, III. 1953, planted in field on 21. III.1953			DISINFECTED AT THE BEGINNING OF MARCH Planted in field on 29.III. 1954		
PENICILLIUM 6	75	4.8	PENICILLIUM 6/b	89	2.38
" 12/a	64	4.8	" 12/b	96	0
" 15	72	5.1	" 12/a	76	0
" 16	61	5.5	" 15/b	85	0
" 17	71	5.1	" 16/c	77	0.75
" 18	70	410	" 17/c	90	0.38
" 39	64	416	" 18/a	80	0
" 31	72	3.5	" 31/a	94	0.88
GERMISAN	84	0.63	GERMISAN	87	0
UNTREATED	87	20.3	UNTREATED	89	7.66

such a disinfecting action, which matches the action of mercuric preparations has been found. In our preliminary experiments we were also occupied with a problem of using antibiotics to control smut (Ustilago tritici and nuda) (Klinkovskii, 1952), and our experiments, apparently, gave a possibility to hope for obtaining an inhibitor for this pathogen also. If this supposition will be justified, than antibiotics will have a greater right to be called universal disinfectants, than mercuric preparations have. We are backed up in our assumption by a circumstance that, independently of us, Leben, Arni and Keit (Leben a. col. 1953) have reported about a

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successful control of smut on barley under field conditions.

The greatest part of plant diseases is caused by fungous organisms. That is why a question arises about prospects for using antibiotics of fungicidal action as disinfectants. Glutoxin and viridin are known as such at present time. Further one should name enniatin, yielded, by Fusarium, gladiolic acid, isolated from Penicillium gladioli, griseofulvin and frequentin which are isolated from soil inhabiting penicilliums, and, finally, antimycin which is isolated from one of the forms of Streptomyces. Antimycin, for instance, inhibits the infection and thegrowth of the pathogen of apple scab (Endostigme inaequalis) and of other phytopathogenic fungi.

Actidione is an important antibiotic of fungicidal action, it is a waste in the production of streptomycin:(Whiffen a. col., 1946) and it was successfully used to control leaf spot of sweet cherry (Coccomyces hiemalis), snow mold (Fusarium nivale), the pseudo parasitic fungus and others. It is effective already in $2:10^6$ concentration and can take place of compounds of copper and sulfur. But the use of actidione is limited because of its high toxicity. Thus, spraying of trees can be conducted only after the fruits have been removed; those trees which cannot bear fruit can be sprayed any time (Dunegan, 1954).

Antimycin deserves much attention, because it does not cause any damage to the plants, is stable to the action of rain, and its combination with insecticides does not influence its stability. Legen and Keitt(1947), as well as Darpoux and Faivre-Amiot (1951) have achieved successes in the control of scab; the latter ones used culture filtrates of two representatives

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of the group Aspergillus niger, as well as Penicillium claviforme. Shcheblykina (1953) reports that in USSR viniculture spraying the vines with diluted extract from semi-decomposed manure (1 part manure, 8 parts water) gave better results in the control of mildew (Begin p. 176) of grapes, than the usually employed dusting with sulfur. Here too it was necessary to take into account antagonistically acting components.

Kublanovskaia (1952) reports about utilization of antagonists-actinomycetes for control of fusarium wilt of cotton. Wallen and Skolko (1950, 1951) succeeded with the aid of antibiotic "XC" which is formed by Bacillus subtilis, to conduct disinfection of seeds which were infected by Aggochyta pisi. In our experiments (V. Gerstner) we worked with penicillium, strain 135/8, which produced a considerable lessening of infection on leaves after a two-hour immersion into a filtrate. At this a considerable stimulus to growth was noted which was expressed in the increase of leaves and a much earlier blooming and development of fruits.

Title of Figure 2. Poppy plants during the phase of ripening. Planting was done with seeds which were infected by Helminthosporium papaveris.

a. - control (without antibiotic treatment); b - experiment. Seeds disinfected by a filtrate of a culture fluid.

(Begin p. 177).

In experiments of our Institute we succeeded to show, that the use of antibiotics on poppies promised successful results not only for the control of Helminthosporium papaveris, but also in connection with

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the stimulation of plant growth, which was traced during the whole period of its ontogenesis (Fig. 2). Nickell and Finley (1954) also reported about a similar stimulating action after the addition of terramycin and penicillin G to the aseptic cultures Lemna minor. Various antibiotics produce a favorable action on the rooting of agave, sorrel, radishes, cucumbers, corn and stimulate the growth of sprouts (Nickell 1952, 1953). Barton and Macnab (1954), Tribben (1954) and Matter(1953) report also about the stimulating effect; whereupon the last one remarks that in decorative plants besides this a change in resistance to diseases, darkening of the flowers and intensification of their aroma were also found.

With the use of antibiotics for the control of pathogenic organisms of fungicidal origin the effectiveness was higher in many cases than with the use fungicides. We can (sentence continues after table 7)

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Table Seven

Results of treatment of 100 apple wildings against infection by Podosphaera leucotricha.

DECOCTION FOR SPRAYING	INFECTED SHOOTS ON TREE							INDEX OF INFECTION
	1	2	3	4-5	6-7	8-9	10-11	
	SPRAYING ON 4. V. 1954, EVALUATION ON 11. V. 1954							
UNTREATED	10	12	-	3	-	1	4	80
1 X "POLIBAR"	7	13	3	2	5	-	-	75
1 X ACTIDIONE	-	-	-	-	-	-	-	-
1 X PENICILLIUM	3	-	-	-	-	-	-	3
	1ST SPRAYING 4. V; 2ND SPRAYING, 11.V. 1954; EVALUATION ON 18.V. 1954							
UNTREATED	10	10	2	3	2	1	5	99
2 X POLIBAR	9	8	-	4	1	4	3	91
1 X ACTIDIONE	1	-	-	-	-	-	-	1
1 X PENICILLIUM	1	1	-	-	-	-	-	3
2 X PENICILLIUM	2	-	-	-	-	-	-	2
1 X STREPTOMYCES	4	2	-	-	-	-	-	8

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show on this example of our own test with parasitic fungus of apples (Podosphaera leucotricha). Parasitic fungus of apples in Germany appears in a form of strong epiphytotics, and up till now their economic importance is increasing. Infection leads to dying off of affected branches and the infected flowers fail to set any fruit. Sulfuric preparations which were used did not give any satisfactory results, and it is not surprising as the fungi mycoliums overwinter under the covar of bud scales. Control with the aid of moistening with sulfur preparations, or with the aid of 2% regular sulfur-lime decoction plus 0.8% of green vitriol does not prevent the initial infection on the appearing leaves. This method protects the new leaves and shoots from further affection by fungi for a limited time only.

The first experiments for the control of pathogen of apple parasitic fungus with the aid of antibiotics were organized in 1953. We used for this purpose undiluted culture filtrates of antagonists from the soil of the experimental field, such as Streptomyces griseus (strain Thren-Radebeil'). In the experiment we utilized only such antagonists, which in tests against certain (Begin p. 178) microorganisms gave at least two zones of inhibition, not less than 20 mm in diameter. The second preliminary selection was done by means of testing Erysiphe graminis on wheat and barley under hothouse conditions. For spraying the apple branches, which were infected by a parasitic fungus, in open fields only those culture filtrates were used, which wholly suppress the parasitic fungus of grain crops. For the first experiments 9 antagonists were used in all. Spraying of infected branches was done by undiluted culture filtrates with full moistening of shoots. Spraying was done during

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bud stage, before blooming and immediately after falling off of petals. (Figure three.) The advantage of antibiotics is that they suppress the initial infection in the developing leaves, and thus destroy the sources of further infection(Klinkovskii, 1954).

Title of Figure 3. Use of antibiotics to control parasitic fungus in apples (pathogen Podosphaera leucotricha): a - control(without spraying with antibiotics); b - the experiment. A tree which was sprayed by culture fluid of Streptomyces albus. Treatment of the plant done on 29. VI, photographed on 2. IX, 1955 (accord. to Keler).

Preliminary test formed a premise for conducting in 1954 of an experiment on a large scale. Through the kindness of professor doctor Knellia-Iena, we received from the production "Ienafarm" several hundred litres of filtrates of submersion culture for the conducting of our sprayings. The filtrate was tested in Naumburg on apple wildlings. Their evaluation (table 7) clearly shows, that already with a single use of antibiotics it is possible to obtain practical, satisfactory results, whereas the use of a sulfur preparation "polibar" does not show any action, compared to the control, even after fourfold treatment.

In 1955 the experiments were continued by application to the trunk of the apple tree, of variety "Belyi naliv," of culture filtrates containing antibiotics and corroborated data of 1953 and 1954. No phytotoxic action appeared. The amount of fruit was also normal. No brown spots were found on fruits.

The first experiment in Germany, which was conducted on a large scale, can be evaluated as positive. About experiments for the control

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of other representatives of Erysiphaceae reports from: Felber and Hammner (Begin p. 179) (1948) with Erysiphe polygoni, and Darpout and Faivre-Amiot (1950) with Erysiphe graminis.

A question arises on the possibility of disinfection of the soil. In our experiment we utilized a soil, which was strongly infected by Helminthosporium papaveris and by other soil parasites. A comparative disinfection was conducted by steam, by formalin (15 c of 1% formalin to 1 m^3) and by antibiotics. It was clearly proved, that with the aid of formalin only partial success was achieved, whereas in a series of experiments with antibiotics the development of phants was clearly stimulated. Can antibiotics be absorbed by phants and be preserved in them in active form? According to Winter and Willeke(1951) antibiotics with molecular weight up to 581 can be absorbed by the roots of plants in an unchanged state. Gaumann, Naef-Roth, Reusser and Ammann(1952) obtained similar results. Penicillin and streptomycin, notwithstanding their foreignness to the organism, remain in plant tissues biologically active. An accumulation in plant tissues was ascertained. Concentration of streptomycin in plant cells increased 7 times compared to its concentration outside the plant (Pramer, 1955). It remains yet unclear if an accumulation is taking a place there or does stretptomycin produce, together with substances contained in cells, some more active compounds, than itself, and this circumstance then explains a higher activity in extracts of cell juice. This can also explain the fact why griseofulvin is more active in vivo, than in vitro. In 3-4 weeks after its single absorption by the roots, the antibiotic can be found in drops

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of guttation. During the following infections of the plant by Botrytis cinerea the antibiotic produced, to a considerable degree, a protective action against the disease. Apparently, an accumulative action takes place here, because an infection by Alternaria solani up to a 15-day period after a single absorption of antibiotic gave negative results. The length of an intra-plant action by individual antibiotics is not yet known; apparently it depends on the antibiotic, which was used, on the pathogenic organism and the type of the plant.

Our experiments (Kohler, 1953) were not at first planned to be for the development of methods of control of pathogenic fungi, which were utilized in tests.

Table Eight

Influence of antibiotics on infection of cauliflower plants by Alternaria circinans.

STRAIN OF THE ANTAGONIST	CONCENTRATION OF CULTURE FLUID IN %			
	10	5	1	0.5
Penicillium 17	0	0	1	1
Penicillium 1 14	0	2	2	2
Streptomyces 153/3	0	0	0	2
Streptomyces 253/4	0	0	0	2
Streptomyces 12/7e	2	2	3	3
Control	3			

Degree of infection: 0 - no infection; 1 - weak infection; 2 - medium infection; 3 - strong infection.

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First of all we wanted to find out how effective are the products of metabolism of our producers of antibiotics, which were isolated from native soils. The plants, utilized in these experiments, were partly grown in Knop's culture medium, and partly in Khoenbokkerovskii quartz sand, which was saturated by the culture medium. In experiments with (Begin p. 180) cauliflower the plants in the phase of 1-2 leaves, were infected with Alternaria circinans. Simultaneously into the culture medium antibiotics were added in descending percentages.

From data in table 8 it can be seen that antibiotics were absorbed as biologically active substances, and that the products of metabolism, which have an antagonistic action in vitro, keep these qualities also in vivo. Influence of antibiotics on the appearance of two forms of rust on grain crops was tested in further experiments. (table 9)

According to a written information from K.O. Miuller, who worked with streptomycin, one should make a distinction between the fixed and the free streptomycin. With the aid of biological tests it is possible to detect only the free streptomycin, whereas the fixed one completely eludes the analysis.

Crowdy and Pramer (1955) came to a similar conclusion. The cited authors think that for a full revelation (the sentence is continued after table 9)

Table 9

Influence of antibiotics on injection of grain crops by rust. (An average number of pustules of rust per plant - from among 10 plants.)

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Table Nine

Strain of the antibiotic	Concentration of culture fluid in %			
	10	5	1	0.5
I. BARLEY Puccinia simplex				
Penicillium 17	-	2	6	3
Penicillium 19	-	2	4	5
Penicillium 1	-	1	2	3
Streptomyces 12/3a	-	3	5	7
Streptomyces N 176	-	-	8	5
Streptomyces 253/4a	-	-	1	-
Control	62	-	-	-
II. RYE Puccinia dispersa				
Penicillium 17	-	-	1	5
Penicillium 19	-	-	3	1
Penicillium 1	1	-	-	-
Streptomyces 12/3a	-	2	1	3
Streptomyces N 176	-	-	3	3
Streptomyces 253/ 4a	-	-	-	1
Control	64	-	-	-

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of antibiotics in plant tissues it is necessary to use highly-specific test-objects or a direct chemical determination of the antibiotic. They compared all the available data of experiments on absorption and translocation of antibiotics and came to conclusion that some antibiotics cannot move along the plant tissues (gramicidin, neomycin, pyocyaninand subtilin) others, on the contrary, move quickly (chloromycetin, griseofulvin, penicillin). Aureomycin, mycetin, streptomycin and terramycin behave differently in plants of different forms. The authors make a conclusion, that the ability to move along the plant depends on the reaction of the antibiotic; substances with neutral or acid reactions (chloromycetin, griseofulvin and penicillin) move easily; antibiotics with an alkaline reaction (neomycin, streptomycin) and with an amphoteric reaction (aureomycin and terramycin) do not spread along the tissues. Apparently there are outlooks for utilization of antibiotics for the control of insects. Thus, according to Vogel (1953) antimycin A has a clear insecticidal action against the house fly, against clothes moth and of larvae of Attagenus piceus. In such cases the matter (Begin p. 181) is not about an immediate insecticidal action. Most of the insects carry within themselves symbionts, that is within them live certain forms of bacteria, which are necessary for the normal course of their living functions. If these bacteria should be destroyed, the insect perishes or, at least, loses its ability for propagation (Musgrave and Millner, 1951). That is why, in a roundabout way, by destroying bacteria in an insect, it is possible to control the "insect-bearer." It is worth mentioning, that the rice curculionidae Calandra oryzae L. perishes after eating wheat grains

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which were saturated with terramycin. Steinhaus and Bell (1953) arrived to similar data with granary and rice curculio midae, with lesser grain borer (Rhizopertha dominica), and with the confused flour beetle (Tribolium confusum). Another mechanism of action of antibiotic on the insect is also possible. Antimycin A, which produces a pdsonous action on some insects and mites, inhibits the system of succin-oxidase or some intermediate phases of oxidizing systems.

Until the present time it remains uncertain if it is possible to use antibiotics for the control of phytopathogenic viruses.

Of late it was repeatedly reported about phenomena of synergism and of antagonism between the plant-growth substances and antibiotics (Bastin, 1953; Jyengar and Starkey, 1953). Increase in length of plant roots, compared to control, after their treatment by penicillin G, by sodium-rimocidin, sulfate of streptomycin and by raw terramycin was found out through Baron and Macnab's observations. (1954). Harris(1953) has shown that dry weight of youngcorn plants increased by 40% with an addition of potassium-penicillin, whereas an addition of procaine-penicillin produced a decrease of dry weight of plants by 20%.

Research into the action of pure plant-growth substances, of combinations of growth substances and antibiotics and of raw culture filtrates or extracts of mold fungi, have shown that in the latter ones are contained simultaneously plant-growth substances as well as substances of antibiotic action. The action of such filtrates on coleoptiles of oats appears as a sum of separate influences, part of which has an antagonistical character (inhibitors). Thus, for instance, penicillic acid in a weak

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concentration acts as a plant-growth substance, but beginning with a dose of 150γ- as an inhibitor.

In experiments by Bastin, penicillium, strain 1377, had a strong growth stimulating action and at the same time displayed a strong fungicidal action against Penicillium brevi-compactum. Iyengar and Starkey also showed that different antibiotics produce a distinct influence on auxin's action. In an experiment with oats, with the addition of terramycin and chloramphenicol, and to a lesser degree - with the addition of streptomycin, an increase in the activity of plant-growth substances was ascertained. Synergistic action of these antibiotics appeared also in the pulp with cucumber seedlings on sterile agar in a humidity chamber. Citrinin produces an inhibition in the action of plant-growth substances, whe eas thiolutin, clavacin, "gluitoksin" and rimocidin do not display neither any synergistic, nor any antagonistic action. Goodman and Hemphill (1954) also think that indole-3-acetic acid causes an increase in antibiotic effectiveness of streptomycin because the protective action against Erwinia amylovora increased considerably.

According to Richou and Kourilsky (1954) the presence of plant-growth substances in culture filtrates is much greater than in purified antibiotics, which already do not have any influence on the plant growth. The presence of lithium enzyme was found in culture filtrates of different antagonists, but they could not be found any more in purified preparations. This makes it understandable why in the control of plant disease best results are obtained from unclarified preparations rather than from pure

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compounds; the more so, because the secondary products are not as toxic for higher plants at operative concentrations of antibiotics. (Begin p. 182)

* * *

The material which is cited above testifies to the fact that the use of antibiotics in the protection of plants opens wide prospects in the control of such pathogens of diseases which were, as was bacteria, until the present time inaccessible to a direct influence and concerning which only prophylactic measures could be taken. It is also possible to achieve positive results in the control of diseases of fungus origin - as it is shown in the instance of the parasitic fungus on apple trees; the effectiveness of these reults surpasses by far the effectiveness of the use of fungicides which were known up to now. Phytopathogy is in worse circumstances, compared to medicine or veterinary science, because intra-plant treatment is possible only in exceptional cases. In this respect antibiotics can produce greqt changes and lift the methods of plant disease control to a much higher level.

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Elsukov, M. P.

O napravlennom povyshenii kachestva kormov.

[Planned improvement of feeds]

Sovet. Zootekh vol. 5, no. 5, pp. 37-46, May 1950. 49 So822

(In Russian)

Development of a public high-productive animal husbandry and improvement of breeding qualities of cattle are in direct dependence on the organization of the feeding base, and on the improvement of the qualitative composition of feeds.

Academician V. P. Vil'iams, pointing out to the necessity of increasing the nutritious qualities of feeds, wrote: "We value feeds the higher, the more nitrogen they contain. Our basic aim -- is to achieve the greatest possible content of nitrogen in forage plants, for which purpose we create an excess of nitrogenous food in the soil." (1)

(1) V. P. Vil'iams - Fundamentals of Agriculture, 1946, p. 95.

Among nitrogenous substances, which go into the composition of plants, the proteins are especially valuable in regard to feeds. That is why the production of feeding plant proteins for the socialistic animal husbandry acquires a meaning of the largest government problem. Planned agrotechnics selection and technology of feeds are called to play a leading role in the solution of this problem.

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Feed crop rotations must become basic means for improvement of the quality of feeds; at their wide introduction the inferior grasses of low nutritive value, which are sometimes inedible and even harmful plants, will be substituted by cultivated grasses of high nutritive value. Economic utilization of low value and low productive lands for feed crop rotations, according to the plan and scale which was specified by the latest Government and Party resolutions, will allow to sharply increase the total harvest of feeds. In the struggle for an increase of these yields, for a sharp improvement of feed quality the first place belongs to feed crop rotations. Planned agrotechnics cannot be realized without a system of crop rotations.

Rate of increase in feed nutritive value in total crop yields depends on the collection of species and varieties of crops, on an increase in the area of plantings of high-productive crops, as also on the efficient care and utilization of natural forage areas which yet remain outside the crop rotations.

In the field of agrotechnics, with the aid of which the living plant organism is not only trained, but its nature is being rebuilt, as also is its heredity--we have before us an unbroken vista of appreciative work. It is by means of planned agrotechnics that it is possible to change in every species and variety the character of nitrogenous and carbohydrate metabolism, and, thus, their chemical composition and nutritive value.

(Begin p. 38)

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Michurin's doctrine ascertains that, by changing the character of metabolism in plants, we change their hereditary properties, that is their former hereditary nature; the plant acquires a new property, and a property which meets our economic interest. To purposefully change a property of the plant during its growth and development--this is the essence of a planned training, of planned agrotechnics.

From many years' experience it is known that it is possible to change for the best the amount and the quality of the yield by predecessors, by a system of soil cultivation, by proper date for planting, by the norm of seeds, by the depth of planting and manner of covering the seeds, by the method of planting, by correct care and time of harvesting, and other measures (without speaking about the quality of seed material). It is often said that if all these measures are fulfilled on time and well--then the yield is guaranteed, and if they are not completed--there will be no yield. But quite often all the enumerated measures are executed, but tritely, without initiative, without contributing anything new.

In order to improve the quality of feeds, it is necessary at first to increase the overall yielding capacity of feed crops, as the quality and the quantity are in indissoluble bonds. Academician T. D. Lysenko underscores, not without reason, that an increase in the yielding capacity of grasses is now the main problem of agricultural workers. When discussing the questions of planned agrotechnics, it is necessary to pay a special attention to one important agrotechnical method which will help to sharply increase the quality of the harvest. We have in view

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mixed plantings of grain and legume crops.

V. R. Vil'iams wrote, that an addition of legumes to the grains especially strongly improves the feeding qualities of hay. When grain and legume grasses are planted separately, the feeding qualities of hay, obtained from either, are lower than when they are planted together. Animal breeders know, that by planting a grass mixture they obtain a full and manifold technical effect.

The field experiments, which were conducted by the Institute of Feeds, fully corroborate V. R. Vil'iams instructions. Data about yields from two harvests (in c/ha) and about the content of protein in straight plantings of timothy and of its mixture with clover (when similar agrotechnical methods were used) are shown in table 1 (according to P. I. Romashev).

Table 1.

Meadow timothy		Clover mixed with timothy	
Yield of hay in c/ha	Contents of protein in hay in kg/ha	Yield of hay in c/ha	Contents of protein in hay in kg/ha
70	468	74.6	745

From table 1 it is seen, that in a mixed planting the amount of protein increases almost two times compared to straight sowing.

Vil'iams' instructions fully pertain to annual feed crops also. This is clearly seen from data, obtained by us (Elsukov) in field experiments in 1946-1949 (calculation was done in % to absolutely dry substance,

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table 2). (Begin p. 89)

Table 2.

Crop	Raw protein	Albumen	Raw cellulose
Oats	10.80	9.82	32.05
Oats with vetchling	22.07	14.77	24.25
Mohar	13.58	10.05	39.07
Mohar with vetchling	21.88	15.67	25.17

As we see, a planned choice of fodders can sharply change the nature of feeds.

The nutritive value of feed plants, particularly their digestibility, must be improved by regulating the periods of utilization of artificial and natural stands of grass for hay mowing or pasturing use.

It is established, that in the final phase of plant development the content of cellulose increases very fast, but contents of the more valuable part, the carbohydrate and protein complex, is diminishing. In order to avoid this it is necessary to harvest the grasses at earlier dates, than is usually practiced. The timely, earlier harvesting of grasses helps to obtain feeds not only with a high content of protein and of the easily digested carbohydrates, but also with a high degree of digestibility. Regulation of harvesting dates is the most important measure for the improvement of nutritive qualities of fodder grasses.

Fertilizers highly increase the yield and help in the accumulation

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of nutritive substances.

Effect of fertilizers on grasses can be twofold: 1) indirect--helping in modification of botanical composition of the stand of grass in increasing the amount of more valuable grasses, and 2) direct--immediately increasing in plants the contents of protein, phosphorus, calcium and other elements.

In individual cases introduction of potassium-phosphate fertilizers increases the legumes part in the composition of the stand of grass by 40-60%. The grain-mixed grasses stand of grass becomes then legumes-grain, which has a greater nutritive value. In the grass mixture appear in quantity--clover, vetchling, vetch (Vicia cracca), and other legume plants (research by S. P. Smelov, P. I. Romashev, and others).

Joint introduction of potassium-phosphate fertilizer together with lime especially strongly influences the botanical composition of a stand of grass on soils in the podzolic zone. In this zone it is impossible to organize planted pasture lands of high productiveness (especially on dry gaps) without liming the soil. Liming helps to keep and develop in the stand of grass the most valuable forms of meadow grasses, and prevents infestations of grass mixtures by hair grass, bent grass, by horsetail and many other weeds and poisonous plants.

Potassium-phosphate fertilization and liming increase the amount of legumes in grass mixtures and decrease a need of nitrogen fertilizing of meadows and pasture lands.

Nitrogen fertilizers usually lower the content of legumes in the

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stand of grass, but at the same time the grass diversity and the content of weeds is lowered. With a systematic nitrogen fertilization the stands of grass are fully cleared from weeds. They become straight grains with a large percentage in them of "~~z~~aznokustovykh" [bushy] plants--such as fescue grass, timothy and other meadow grasses of high (Begin p. 40) nutritive value. Mineral fertilizers are a powerful means for the control of weeds on grass fields; they improve the botanical composition of stands of grass, increase the legumes portion in one case (when potassium-phosphate fertilizers are introduced), and, in the other, of bushy and rhizomatous grains (when nitrogen fertilizers are applied).

It is necessary to dwell on the question of nitrogen fertilizers. When properly utilized they are a powerful means for increasing protein content in grasses. The plants have an ability to fix almost all the mineral nitrogen which they absorb, transforming it into organic forms (mainly into albuminous compounds). At the same time the proteins can be used for the formation of new cells and organs of the plant in the presence of abundant nitrogen nutrition and are stored in the newly formed cells; the amount of protoplasm--the basic source of protein in plants--increases. Thus a possibility is created to sharply change the content of protein in grasses. It is possible to regulate, by means of fertilizers, the content of protein in grasses to about 25-30%.

The best hay of average water meadows contains: protein 11%, cellulose 28%, phosphoric acid (P_2O_5)--0.6%, and calcium (CaO)--0.7%. Grasses of best pastures in USSR--Alpine, sub-Alpine and dry gap--contain in dry

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substance: protein 16%, cellulose 25%, P_2O_5--0.5% and CaO--0.7%.

According to data of Institute of Feeds, the content of protein in pasture grass with the introduction of nitrogen fertilizers, in a dose of 90 kg of nitrogen per ha, increases from 12.7 to 18.9%. On water meadows of Gorkovskaia oblast' an introduction of nitrogen fertilizers increased the content of protein in hay from 7 to 14.4%.

Numerous researches testify about the positive action of nitrogen fertilizers on the content of protein in all grain feed grasses. Nitrogen fertilizers give a possibility to prepare from feed grasses concentrates with a high content of proteins, vitamins, and other substances which are important for the nutrition of animals. For this purpose the fertilized stands of grass are mowed early and the grass is dried artificially.

Besides this, introduction of nitrogen fertilizers to grain grasses, under conditions of timely mowing down of the latter, allows mowing hay from the rank of coarse forrage feeds into a group of concentrates. Academician V. P. Vil'iams pointed repeatedly to this necessity.

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Table 3.

Planted meadow (All-Union Scientific Research Institute of Feeds)			Natural water meadow (river Oka) (experiment by Institute of Feeds		Natural dry gap meadow (experiment by Lorilskoi Experimental Station in Armenian SSR)	
Fertilizers	Yield of hay in c/ha	Protein in kg/ha	Yield of hay in c/ha	Protein in kg/ha	Yield of hay in c/ha	Protein in kg/ha
0	22	194	26.4	290	7.1	84
PK	24	251	27.8	305	10.6	137
$PK+N_{30}$	36	510	32.6	359	16.6	202
$PK+N_{60}$	48	536	48.6	534	22.5	281
$PK+N_{90}$	56	705	56.5	621	26.8	335

(Begin p. 41)

It is possible with the aid of fertilizers not only to increase the general content of protein in feed grasses, but also to change its quality-- increase digestability and biological value of protein. This depends on the form of nitrogen fertilizer. Ammonium and nitrate forms of nitrogen react differently.

Table 3 shows how the yields and content of protein in grasses on planted and natural meadows are changed, depending on the fertilizers.

A special attention should be given to widening and renewing the assortment of the feed plants, by bringing in new, more valuable species and forms of wild growing grasses. This work should be widely organized.

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The whole net of Scientific Institutions, as well as wide masses of kolkhozniks and workers of sovkhozes should be drawn into it.

Among the wild growing flora there are such species and forms of plants which can be cultivated on a mass basis without any great change in their nature. But there are other species and forms of wild growing plants which cannot be widely cultivated without a fundamental change in their nature. But individual economic properties and qualities of these plants are very valuable and must be utilized for the improvement of cultivated plants. Besides this, among the wild growing fodder grasses one meets species and forms with certain exceptionally valuable economic properties. Yet some of the properties of these plants are negative and their biology is very difficult to change, in other words, their nature is very conservative. That is the reason why it is necessary to study deeply the biological peculiarities of these grasses, the reason for their conservatism, and after that to shatter the conservative hereditary base and by means of planned training to get rid of unwanted qualities and properties, or at least to decrease their negative influence. "Succeed in changing the type of metabolism," says Academician T. D. Lysenko, "and you will change the heredity." New conditions and high agrotechnics will change the direction of physiological processes, will allow to find out new productive capabilities in connection with the fact that the character of metabolism will be changed in plants.

In latter years the co-workers of the All-Union Scientific-Research Institute of Feeds (Trofimova, Simonov, and others) have ascertained that

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in Altai grows a valuable form of meadow, late-ripening timothy (Phleum prafense). In contrast to the common cultivated timothy, this wild growing timothy ripens, in its seeds, simultaneously with the late-ripening red clover, which fact affords a possibility to harvest simultaneously both the seeds of clover and of timothy. In 1949 we propagated the Altai meadow timothy (late-ripening) for seeds in kolkhozes of Ivanovskaia and Moscow oblast' on an area of 7 ha. Its introduction into cultivation will considerably simplify the solution of a problem which was introduced by V. P. Vil'iams--to obtain seeds from grass mixtures.

The canary grass (Phalaris arundinacia) presents no smaller interest. Under production plantings it shows good qualities. Unlike timothy and meadow fescue grass it grows fast in spring and after mowings. During a vegetative period it gives two dependable mowings with an average yield of hay up to 70 c/ha and more. The grass is usually ready for the first mowing during the second half of May. The canary grass is usually regarded as a moisture-loving plant. Yet in 1947-1948 when the rains were few, it appeared to be more drought-resistant when compared to timothy and meadow grass fescue. Canary grass is also of great interest as (Begin p. 42) a component of legumes in feed crop rotations in the non-chernozem zone of Soviet Union.

In Northern Caucasus, in Armenia, in Georgia, In Daghestan, and in Azerbaijan is found a new legume plant, the eastern goat's-rue (Galega officinalis). When tested in non-chernozem zone of USSR the eastern goat's-rue turned out to be unusually early-ripening, cold resistant and perennial.

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It gives two mowings during a vegetative period, with an average yield of hay from 50-104 c/ha. The first mowing of hay is conducted at the end of May or beginning of June, and thus can be utilized for green feeding, for early silage, or for hay. But goat's rue presents the greatest interest as a legume component in fodder crop-rotations.

In the valleys of rivers in the central and northern zones of the Union often is found a vetch (Vicia cracca). In tests, in the valley, it showed a great longevity compared to red clover. It remains in the stand of grass up to 4-6 years, withstands inundation well, gives an extraordinarily tender mass, which is rich in protein and is well consumed by animals. It too is of great value for feed crop rotations, which are started in meadows, and also for additional sowings on natural meadows and pastures.

Data obtained as a result of comparative sowings of wild growing plants, during their introduction into cultivation, on fields of the All-Union Scientific-Research Institute, is given in table 4.

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Table 4.

Name of grasses	Yield of hay in c/ha	Number of mowings during a vegetative period	Yield of hay in c/ha	Remains in the stand of grass (years)	Foliation in %	Content of protein in hay (in % to absolutely dry matter)
Eastern goat's/rue	80-104	2	2-6	10 or more	60-70	15-22
Vetch	50-60	1-2	0.4-1	4-6	50-60	12-15
Timothy, late-ripening, from Altai	28-46	1-1.5	3-6	4-5	50-70	-
Canary grass	96-120	2-4	1-2	10 and more	-	19.7 (protein)

* * *

Research about natural cross-pollination begun back in 1938, and about artificial hybridization utilizing local and wild growing grasses turned out to be more effective compared to methods of selection of grasses, which were used before that time(after the example of works with grain crops).

Experiments with natural intervarietal cross-pollination on Mitrofanovskii base of the All-Union Scientific-Research Institute of Feeds in 1938-1941 gave excellent results. With a natural free cross-pollination of two best (under conditions of Voronezh oblast') varieties--population of alfalfa seeds were obtained which were (Begin p. 45) more productive, than seeds of two initial varieties. Thus, alfalfa seeds which were obtained from free cross-pollination of Grimm-Zaikevich alfalfa with Morchanskaia 81, during the first year of the use of the stand of grass gave a yield of 265 c/ha, whereas the seeds which were not cross-pollinated--only 251 c/ha. The seeds of alfalfa, which were obtained from free pollination

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of Morshanskaia 81 with alfalfa Grimm-Zaikevich, gave a yield of 265 c/ha of green mass, and seeds that were not cross-pollinated--247 c/ha.

Works on interspecies cross-pollination of alfalfa, which were conducted in 1937, allowed to introduce into production a new northern crop population of alfalfa well adopted and stable in non-chernozem zone. This population was obtained by means of cross-pollination of local wild alfalfa of a species Medicago borealis (Northern alfalfa) with alfalfa cultivated for many years. As every wild form, the local wild alfalfa had a great conservative heredity. That is why in 1937, in order to obtain the plastic forms, wild alfalfa was crossed with cultivated under conditions of Omskoi oblast' and Krasnodarskii krai.

Hybrid plants, with obviously shattered heredity, were obtained in the second generation. These hybrids were trained in Moscow oblast' on podzolized soils. Growing the population of cultivated Northern alfalfa under conditions of high agrotechnics played a big role in its training. This helped in the development of such properties as the speed of growth, production of grass for repeated, many years' mowings, high productivity.

The main advantage of the new cultivated population of alfalfa Northern Hybrid 69, which was bred in this way, is its adaptation to the conditions of non-chernozem zone, and also the linked-to-it ability of the plant to give higher yields of seeds.

The seed producing ability of Northern Hybrid 69 ~~yield~~ alfalfa and its comparison in this respect to alfalfa Grimm-Zaikevich (in experiments in Moscow suburbs) is shown in table 5.

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Table 5.

Name of alfalfa	Yield of seeds in kg/ha				
	Years				
	1940	1944	1946	1947	1948
Northern Hybrid	250	190	101	225	316
Grimm-Zaikevich	19	7	3	6	13

At the same time alfalfa, Northern Hybrid, is distinguished by high yielding capacity, surpassing in this respect alfalfa Grimm-Zaikevich by 30% with a yield of 70-100 c/ha, and the wild population by 45-50%. This high productiveness of Northern Hybrid 69 is retained (and even with some increase) in the course of seven generations.

Yielding of hay by Northern Hybrid 69 alfalfa compared to the yielding capacity of other alfalfas is shown in table 6.

At present alfalfa, Northern Hybrid 69, has been turned over for propagation and productive evaluation to kolkhozes and sovkhozes of Moscow, Ivanovskoi and Kostromskoi oblast'.

Positive results were also obtained from utilization of free cross-pollination of red clover and some grain grasses. (Begin p. 44)

Table 6.

Name of alfalfa	Tests, 1940-1948		Planting in 1947 (sixth generation)	
	Yield of hay in c/ha	in %	Yield of hay in c/ha	in %
Northern Hybrid 69	69.32	152	103.3	158
Grimm-Zaikevich	52.38	112	70.6	108
Northern wild	45.67	100	65.2	100

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Wonderful results were obtained by the Ukrainian Branch of the Institute of Feeds (Iatsenko) with interspecies cross-pollination of esparsette (Onobrychis). At present the Branch is handing over for production several valuable hybrid populations (No. 2842, 2855, and others), to be propagated in Poltavskoi, Krivogradskoi, and other oblast' in Ukraine.

Table 7.

Name of the crop	Initial material	Improved material
Alfalfa	Grimm-Zaikevich, yield of hay 42.4 c/ha (100%). Resistant to winter cold	Ukrainskaia 256, yield of hay 51.7 c/ha 122% Grimm-Poltavskii: 47.6 (112%) Poltavskaia 6800, 103% Much more resistant to cold.
Alfalfa	Northern wild, average yield of hay 45.6 c/ha (100%) gives one mowing.	Northern Hybrid 69, 69.3 c/ha (152%), gives 2-3 mowings.
Esparsette	Common 665, yield of hay 25 c/ha (100%), resistant to cold, 62% of overwintering, gives 1 mowing.	Hybrid 2795, yield of hay 35 c/ha (140%), 76% of overwintering, after-grass 25-60% from 1st mowing.
Esparsette	Zakavkazskii, yield of hay 32 c/ha (100%), 36% of overwintering, gives one mowing.	Hybrid 2855, yield of 40 c/ha (125%), 70% of overwintering, after-grass 25-50% from 1st mowing.
Clover	Wild, from Altai, stalkiness 14.19 (100%), weight of seeds per 1 plant 55 g (100%).	Clover D-216, stalkiness 27.7 (199%), 12.2 g (220%)

[Table 7 continued on p. 17]

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Table 7 (continued)

Name of the crop	Initial material	Improved material
Timothy	A series of best selections and local timothies, yield of hay 41 c/h (100%) and 42 c/ha (100%), foliation 30.9%.	Timothy No. 5 (intravarietal cross-pollination), yield of hay 53 c/ha (130%) for 3 years of use and 45 c/ha (106%) for 5 years of use.
Timothy	From Altai, wild, yield of hay 33 c/ha (100%).	Late-ripening, improved, 45 c/ha (136%), ripens together with clover.

(Begin p. 45)

All these facts were not generalised at the time. No specific conclusions from them were made. Only after the August session of the All-Union Academy of Agricultural Sciences im. V. I. Lenina the method of selection was critically reviewed and a project of methodical instructions for conducting selection work with perennial grasses was worked out. The plan specified a unity of selection-seed growing process with the aim for a quickest provision of kolkhozes and sovkhozes with high-yielding seeds of perennial grasses.

"The most important problems," wrote I. V. Michurin, "are, in my opinion, the necessity to renew the assortment, banishing absolutely all that which is not fruitful, all which is too exacting to agrotechnical care, all which is obsolete, sickly and parasitical; to breed local varieties for new industrialised largest sovkhoz-kolkhoz centers." (1)

(1) I. V. Michurin. Works, vol. IV, p.255, Sel'khozgiz, 1948.

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The principal attention in this plan of systematic directives is drawn to the necessity of finding on a larger scale of valuable local and wild populations, as well as their fastest assimilation and introduction into production. Improvement of populations and formation of new valuable populations the project recommends to conduct not through selection, which involves the narrowing of heredity, but by means of wide use of intravariety and interspecies free cross-pollination and artificial crossings, with a following, planned training of the initial material in the course of the whole process of propagation.

It is quite clear, that the works of, for increasing, the number and quality of feed yields do not have to be limited only to planned agrotechnics and selection. An extremely big role here should play also technology and conservation of feeds.

At first sight it seems impossible to change the yield of feeds, grown in fields or meadows, either in its amount, or quality. But this is an erroneous opinion. Research, which was conducted by the Institute of Feeds under the leadership of Professor A. A. Zubrilin, allows to insist upon full possibility of planned qualitative remaking of feeds, beginning with hay, silo and finishing with protein-vitamin pastes.

It is well known that cattle should not be just fed, but fed in such a way as to obtain from it maximum production. Science and practice have ascertained that by feeding cows in summer on good pasture by grass and other green feeds, and in winter--by nutritious hay, root crops and silage, it is possible to get up to 5000 l and more per year per cow. However,

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the productive ability of livestock cannot by far be made apparent with such a type of feeding. Pedigreed cattle can double and triple these yields of milk, if the problems of growing, preparation of feeds and of feedings are solved by the farmers purposefully, according to vital requirements of the animal's body.

Now it is possible to hold it as proved, that even the concentrated type of feeding of prolific milch cows does not, by far, disclose all production possibilities of the animals, although it promotes a sharp increase in their yield of milk.

Only with a certain combination in the ration of various feeds is it possible to correctly solve the problem of protein, carbohydrate, mineral and vitamin nutrition for highly productive animals.

Not only do various feeds have a different production effect, but even the same groups of nutritive substances in different feeds differ in their qualities. As it is known, digestibility (Begin p. 46) and biological value of protein in various feeds are not alike. What is in common, for instance, among non-nitrogenous extractive substances in such feeds as straw, potatoes, root crops and grass? In one case this group is rich in sugar, in another in starch, in the third in pectin substances, in the fourth in pentosans, and so on. The same can be also said about the composition of celluloses in potatoes it is of one nature, in corn of another.

All this stipulates a different specificity of the physiological effect of feeds.

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Technology of the preparation of hay, of silage and of new forms of concentrated feeds can, to a considerable degree, change the nature of different nutritive substances, to increase their productive action; and thus is obtained a possibility for fundamental improvement in feeding of animals by means of planned technology.

Controlling the biochemical methods of preparation of hay and silage, it is possible to change the quality of feed, to increase its digestability and enrich it anew with very important amino-acids-lysine and tryptophans. It is possible to prepare ensilage for calves, for young pigs, for colts and high-productive cows, valuable conserves as from fresh, so also from steamed grass. Through the activities of co-workers of the All-Union-Scientific-Research Institute of Feeds it was ascertained, that the new form of protein-vitamin concentrate from grass (Prof. A. A. Zubrilin and S. Ia. Zafren) possesses a clearly expressed stimulating effect on the organism of growing calves and young pigs. A wealth, in this product, of both proteins and lipoids gives a basis to affirm that the protein-vitamin pasts will play a big role in fat increase in milk.

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SECTION VI.

Selection of Potatoes

Chapter I (p. 548-552)

PRESENT SITUATION AND THE NEXT TASKS OF POTATO SELECTION IN THE USSR

One of the first potato selectioners in Russia was the gardener E. A. Grachev who developed a series of potato varieties in the peterburg District during the second half of the 19th century. According to certain data, there is reason to assume that the varieties of Alcohol [Alkogol'] with the white and violet flowers which have survived until now were developed by E. A. Grachev.

The first steps in scientific potato selection were taken in 1903 by Prof. D. L. Rudzinskii at the former Petrovskaia Academiia, now the Agricultural Academy im. K. A. Timiriazev. In pre-revolutionary Russia, however, problems of potato selection were given no consideration and

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practically no success was achieved in this sphere.

It was only after the Great October Socialist Revolution, which opened up vast possibilities for the multilateral development of science in our country, that potato selection gained the scope which was its due. Concurrently with the restoration of all agriculture and with the rapid increase in the production of potatoes for food, technical and fodder purposes, extensive work unfolded in the selection of this most valuable crop.

In 1920, a department of the Moscow Regional Agricultural Experiment Station was organized near the village of Korenev in the Ukhtom District, Moscow Region, and was made responsible for the work of potato selection. In 1929 this department was reorganized and became the Korenev Potato Selection Station, and in 1930 the Scientific-Research Institute of Potato Economy was founded at its base.

Concurrently with the Korenev Department of the Moskow Regional Experiment Station, another center for scientific potato selection was created in 1921 at the All-Union Institute of Applied Botany and New Crops.

In the years between 1922 and 1930 experimental stations were organized in a number of republics, territories and regions, and departments for potato selection were opened at many experimental stations.

From the first days of its organization the Korenev department began to collect specimens of potato varieties distributed on peasant farms and proceeded to resolve problems of cultivating seedlings derived from self-pollination and from crossing, and also methods of variety testing.

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etc. In 1929 the Korenev Station submitted for production the first potato varieties of Soviet selection--Lorkh and Korenevskii.

Methods of potato selection worked out in the first period by the Korenev Selection Station and by the All-Union Institute of Applied Botany and New Crops were improved and supplemented in the process of further investigations. To secure a more reliable and correct evaluation of varieties and seedlings the method of dynamic and ecological variety testing was put to use. [Begin p. 349] This permitted a more detailed evaluation of the properties of new varieties. Methods evaluating disease resistance of varieties were beginning to be applied to potato selection; aiming at the selection of forms resistant to these diseases, methods for mass artificial infection of seedlings by phytophthora, ring rot, black leg, etc. were developed and put to use.

In 1928 potato selection entered a new phase--work was begun in crossing wild species of potatoes with cultivated varieties. That year, at the Korenev Department of Potato Selection, the cultural variety of Granat was crossed for the first time (by E. M. Uspenskii) with the wild potato species S. demissum, and berries [iagody] were obtained. The following year interspecific hybrid seedlings were grown for the first time from the seed gathered from these berries. By means of backcrossing one of these hybrids with the Granat variety and a further crossing of a seedling of this backcross with the Narodnyi variety, the first phytophthora resistant, economically valuable potato variety No. 8670-a/31 was obtained (by E. M. Uspenskii and M. A. Potresova) in

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world practice; it was named "Pitoftoroustoichivyi" when it was regionalized. Later it was established that this variety is also frost resistant (survives 3-4° C of frost) and canker resistant. The No. 8670-s/51 variety has been used and is being used up to now successfully by a number of selectioners as a maternal plant which produces in its offspring phytophthora and canker resistant varieties.

An expedition of scientific workers of the All-Union Institute of Plant Culture to South America and Mexico discovered a large quantity of cultural and wild potato species which possess economically very valuable properties and biological characteristics--phytophthora resistance, frost resistance, high albumin content etc. On the basis of these wild species and local selection potato varieties, Soviet scientific institutions have unfolded extensive investigations in the sphere of interspecific hybridisation.

The newly developed varieties were expected to be resistant to canker, phytophthora, frost, the Colorado beetle etc. Nonetheless, potato selection in this period took a somewhat one-sided course. Interspecific hybridisation began to triumph over the intraspecific kind by utilising the material indicated.

The enthusiasm for the "wild potato" was so great that at one time intraspecific crossing withdrew to second place. The use of South American forms for selection was considered practically the only possibility of solving all long suffering problems of potato culture. Interspecific hybridisation was set against intraspecific.

Further experience showed that the means of obtaining an economically

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valuable interspecific hybrid is very complicated. This work presented considerable difficulties: crossing of selection varieties with wild forms was often unsuccessful; the hybrids of such crossings possessed a number of valuable properties, but at the same time persistently retained their wild characteristics; under conditions of a long day tubers nearly failed to form etc. As a result, it became necessary to change essentially the method of interspecific crossing, primarily in a direction that would improve the offspring by means of repeated backcrosses and selection of parent forms.

It was, however, only after the scientific-research institutions had become conversant with Michurin's teaching, especially after the August 1948 session of VASKHNIL [All-Union Academy of Agricultural Sciences im. Lenin] which shattered the Mendel-Morgan reactionary trend in biology, that they reexamined resolutely a series of theoretical laws and methods of selection work with potatoes. The methods of Michurin's advanced, materialistic, agrobiological science were the underlying principles of selection: correct selection of parent forms, introduction of the mentor, application of the intermediary [posrednika], [Begin p. 550] improvement in crossing capacity by means of vegetative rapprochement and use of pollen mixture, directed training etc.

At the present time potato selection is conducted over a wide front in all zones of the Union of the SSR. Our scientific institutes and experimental stations occupy right now first place among the institutions of the world engaged in the selection of potatoes. In 1950 more than 40

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scientific-research institutions were practicing potato selection. They developed over 60 new valuable native potato varieties which are being adapted to production in the appropriate regions.

The varieties developed in Krainii Sever [Extreme North] are: Murmanskii, Imandra, Poliarnik, Khibinskaia skorospelka, Khibinskii (Polar Section of the All-Union Institute of Plant Culture), Khrennikovskii, Igarskii, (Igarka Experimental Station of the Institute of Polar Agriculture), Maryanchanin and others (Marya Experimental Station).

In the East and Southeast, under conditions of a distinctly continental climate, drought and irrigated agriculture, the following potato varieties were developed: Podarok rodine and Novinka pustyni (Cis-Aralsk Experimental Station), Sverdlovskii, (Sverdlovsk Vegetable Experimental Station), Ul'ianovskii, Volzhanin, Selanets 1004-4 and a series of others (Ulianovsk Zonal Station of the Institute of Potato Economy), Sibiriak (Siberian Scientific-Research Institute of Grain Economy), Tulunskii (Tulun State Selection Station), Stepniak (Shortandinsk Experimental Station), Severnaia rosa (Kirov Experimental Station), Krasnoufimskii and Ural'skii (Krasnoufimsk Selection Station), Oktiabrenok, Promyshlennyi, Iubileinyi and others (Petrovsk Selection Station, Penza Region), Kazanskii, Selanets 520 (Kazan Regional Selection Station).

In the West the varieties adapted to production are: Trudovoi, Agronomicheskii, Zven'evoi, Zaozerskii (White Russian State Selection Station), Kalev, Kungla (Tygev Selection Station, Estonian SSR), Priekul'skii, Vale, Eksport (Latvian Selection Station).

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In the South and in the Ukrainian SSR the varieties developed are : Stakhanovskii, Chervono-Spirtovyi and others (Kiev Experimental Station of VNIISP), Sevan (Erevan Regional Experimental Station).

In the Central Zone, as a result of selection the following potato varieties were obtained: Moskovskii, Sovetskii, Fitoftoroustoichivyi, Peredovik and others (Institute of Potato Economy), Voronezhskii (Orlov Zonal Station of the Institute indicated), Zavodskii (seedling 15627), Mikhnevskii (seedling 15567)(Moscow Experimental Station VNIISP), Epron, Kalitinets and others (Leningrad Regional Potato Experimental Station).

Potato selection is conducted also at the Central Asian, Maikop, Kuba and Dal'nevostochnaia [Far Eastern] Experimental Stations, at the Odessa Genetics Selection Institute im. T. D. Lysenko, and at a number of other scientific-research institutions, bases of agricultural institutes, technicums etc. A large army of potato growing selectioners of the Union of the SSR strive to develop varieties adapted to certain concrete conditions of the zone in which they are located. The guiding principle in the work of selectioners is the basic law [poloshenie] of Michurin's agrobiology that external conditions train the young plant and external environment becomes a necessary condition for its individual development and existence.

All scientific-research work dealing with the selection of potatoes is directed by the All-Union Institute of Plant Culture and the Institute of Potato Economy. [Begin p. 351]

At present, the basic method for the development of new potato varieties is hybridization and subsequent creative selection from among the

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seedlings obtained. Cultural selection varieties, as well as wild potato species and their hybrids of different generations (F_1, F_2, B_1, B_2 etc.) are used as parent forms in hybridization with selected varieties. A series of the potato varieties which have been developed represent very complex hybrids obtained in direct crossing, backcrossing and reciprocal crossing.

A new method which opens big prospects for the development of valuable varieties and increases the rate of potato selection is vegetative hybridization based on the teaching of I. V. Michurin and T. D. Lysenko. The feasibility of obtaining vegetative potato hybrids has been demonstrated by many workers of the Institute of Potato Economy and other scientific institutions dealing with potato selection. At this time several vegetative hybrids have already been regionalized as varieties. However, in view of the fact that the theory of selecting components has not yet been defined clearly enough, and their reciprocal actions, and some other questions have not been studied sufficiently, this method of selection must, for the time being, be utilized widely in combination with the method of sexual hybridization.

In the process of developing of and becoming familiar with Michurin's scientific legacy, other Michurin methods were also being adapted to potato selection. Problems of directed training of seedlings and parent forms are included in the working plans of almost every selectioner. Efforts are made to study and to determine conditions essential for directed training of potato selection material. Selection of parent

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pairs is conducted in accordance with the principles of I. V. Michurin's teaching concerning transmission of valuable hereditary characters in distant crossing and special training of the parents.

Potato growing selectioners apply the method of an intermediary, vegetative rapprochement, pollen mixture etc., which completely eliminates the difficulties comprised in the non-crossability of separate species with selection varieties. This expands considerably the possibilities of recruiting different potato species for selection work.

Of immense significance to potato selection is screening [otbor]. In the era of Morganist and Weismannist dominance selection was considered merely a sanitary measure. This was based on the fact, so to say, that selection cannot alter a variety or change its hereditary properties within the limits of a pure line-- a clon. Michurin's agrobiology has demonstrated the complete incompetence of this "scientific" law. Purposeful selection based on the methods of Michurin's genetics gives the selectioner a powerful tool of influencing the nature of the potato plant. By selection of clons and their simultaneous directed training it is possible not only to improve the economic properties of a variety, but also to alter its nature by inheritance, i.e. in the desired direction. Hence, at present, screening in selection (clon selection among seedlings, varieties and grafts), as well as in seed growing (clon and by plant [pokustnyi]) has assumed exceptionally great significance.

Soviet selection each year adapts ever more of its newly created valuable potato varieties, increases the scope and scale of its work in

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bringing out highly productive varieties with a high content of starch, possessing the combined resistance to phytophthora, canker, frost, drought, pests, etc. The present status and development of our [native] selection justifies fully the assumption that, in the nearest future, the entire area cropped to potatoes will be provided with the most productive native selection varieties. [Begin p. 352]

Scientific-research institutions dealing with the selection of potatoes are faced by the following sequence of tasks:

1) to develop new, highly productive potato varieties resistant to canker, the Colorado beetle, phytrophthora, and degeneration diseases, highly productive varieties for irrigated regions, and also early ripening ones;

2) to revise selection schemes and methods from the standpoint of Michurin's genetics and, in the shortest possible time, to ensure fully the application of the principles and laws of Michurin's agrobiological science to the work of potato selection;

3) to conduct a series of corresponding scientific-research work for the solution of unclear biological questions pertaining to the potato plant:

a) to define concretely the meaning of "superior agricultural background" ["vysokii agrofon"] and to establish a system of fundamental measures that will create superior agro-ground for the selection of potatoes under the concrete conditions of any geographical point;

b) to study the influence of different fertilizers upon the plant

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trained, including microelements, cultural conditions, irrigation, the combined effect of the training stock with different root nutrients, etc.;

c) to determine the influence of the best conditions of atmospheric nutrients upon young hybrid seedlings, i.e. training on extensive areas which undoubtedly will facilitate an increase in their leaf (assimilating) surface and, consequently, also an increase in hereditary productivity; to test hill-check planting (3-4 plants per hill), parallel with the planting of seedlings in the field, for their better development in a community [of plants] and with the possibility of one plant being subsequently left;

d) to test and adapt the method of summer planting of seedlings, and testing of se dlings for selection under conditions of spring and summer planting as to their resistance to droughts and heat;

e) to revise the methods of rejecting first year seedlings as plants with shattered heredity, which change appreciably in further vegetative propagation, according to economic characters (productivity and starchiness). The existing method of rejecting first year seedlings often leads to errors in selection;

f) to investigate which tuber under the seedling or variety vine possesses the best seed properties in order to render the work of clon selection more successful; to explain in what order tubers perform setting under the vine, and which tubers as a result of this possess the best seed properties;

g) to investigate conclusive evidence of the concept of "clon" as

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being the offspring of a separate bud of a tuber due to the diversity of tissues and buds within the limits of a tuber;

h) to study and determine to what extent and how the physiological characteristics of the potato plant conform to its age at different stages;

4) to substitute within the next few years the best potato varieties of native selection, which are more productive and more valuable for food and processing purposes, for foreign varieties.

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Translation A-734
(In full)
bn/A

A 734

Fedchenko, M. A.

Novyi iad dlia bor'by s vrednoi cherepashkoi.

[A new poison for the control of Eurygaster integriceps.]

Priroda, vol. 46, no. 4, pp. 96-97. Apr. 1956. 410 P935

(In Russian)

In the southern regions of our country Eurygaster integriceps is the most dangerous pest of winter and spring wheat. It spends the winter mainly under fallen leaves in forests, orchards, brushwood and tree belts, and with the approach of warmer weather (April, May) it flies onto the fields. The moment the yield has been gathered Eurygaster integriceps flies to its hibernation habitat. It is injurious to the young crop for 2 1/2--3 months, the rest of the time it remains in its hibernation place.

Plants are injured by the adult Eurygaster integriceps as well as by its larvae which suck the juice from the young plants, the stems and the ripening grain of wheat. By injuring the crop, Eurygaster not only reduces the yield, but it also completely destroys it. Grain which has been injured by Eurygaster larvae loses germination and produces flour that is unfit for bread baking.

In 1949 the Krasnodar Territorial Experiment Station for Plant Protection proposed that control of Eurygaster integriceps and its larvae be accomplished by a chemical method with the aid of DDT dust. At present

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DDT dust is applied extensively in the Krasnodar Territory and in a number of other regions as the best method of Eurygaster control. However, experimental and industrial treatments have shown that DDT dust does not always produce good results in the control of this pest. Thus, for example, its effect on the bug in cold weather was negligible, its action against older larvae inadequate, and it fails to affect the bugs of a new generation.

The Krasnodar Experimental Station assumed the task of finding a new, more effective poison for the control of Eurygaster and its larvae.

In 1953-1954 the station, in cooperation with the kolkhozes "Pamiat' Il'icha" and im. Stalina (Mar'iansk Machine-Tractor Station) and "Leninets" (Platnirov MTS) conducted experimental work testing new poisons on an area of 250 ha cropped to winter and spring wheat.

Of a whole series of preparations tested vofatox produced exceptionally good results. In laboratory experiments it caused a 100% destruction of the bugs within 5 hours, and of larvae within 1--2 hours. [Begin p. 87] Experiments conducted in 1953 demonstrated that vofatox treatment applied to the young crop of spring wheat with an auto-duster (AO2-KPE) at the rate of 20 kg/ha killed within 14 hours 66% of the bugs, and at the rate of 40 kg/ha--100%. On a test plot dusted with 5.5% of DDT dust, destruction occurred later, and after 8 days [192 hrs] it equalled 46%. Experiments initiated in 1954, which applied vofatox at the rate of 20 to 30 kg/ha, led to a 90.5--100% destruction of the bugs.

Dusting of the young crop of winter wheat by aircraft at the rate of

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30 kg/ha in 1954 led to complete destruction of the pests.

A check made of the effectiveness of various doses by dusting crops with a knapsack apparatus (ORM) confirmed the fact that vofatox applied at the rate of 20 to 40 kg per ha causes a 100% destruction of the pests.

In 1955 experiments were conducted in spraying crops with a vofatox suspension together with herbicides (2, 4-DU). The best results were obtained from 16 and 20% suspensions which caused a 94-95% destruction of bugs in 24 hours (at the consumption rate of 100 liters per ha). A DDT suspension (20%) destroyed in the same space of time only 60% of the bugs. There was no destruction of bugs on the control test plot.

The vofatox preparation proved to be a highly effective poison against over-wintered pests, the larvae of all ages, and bugs of the new generation under laboratory and field conditions. Laboratory and field experiments have established also that vofatox retains a high degree of toxicity against the bugs for two days [48 hrs.].

Vofatox was tested also against alfalfa pests. The experiments demonstrated that it exerts faster action upon these bugs than does DDT dust.

By the character of its action this preparation is basically a highly effective contact poison.

It must be noted that the straw, grain, and grain waste from dusted test plots were tested by the Krasnodar Experimental Veterinary Station and were found non-poisonous for livestock.

As a result of its rapid and high effectiveness, the new vofatox poison will, undoubtedly, find wide-spread application against pests of agricultural crops, and primarily against Eurygaster integriceps.

Krasnodarskaia Kraevaia Opytnaia Stantsiia
Zashchity Rastenii (St. Pashkovskaia)

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Translation A-735
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Rastegaeva, E. M.

Vnekornevaia podkormka kak mera bor'by s buroi rzhavchinoi pshenitsy.

[Supplementary foliar feeding as a means of leaf rust control on wheat.]

Zemledelie, vol. 3, no. 3, p. 114, Mar. 1955. 20 Z44

(In Russian)

A-735

The Rostov Plant Protection Station used mineral fertilizers in foliar feeding of winter wheat for the purpose of leaf rust control.

Experiments with regionalized varieties of the winter wheat Odesskaia 3, and of the spring wheat Melianopus 69 and Al'bidum 43 were conducted in 1952 on the "Zavety Il'icha" kolkhoz, Veselovka District, and in 1953 on the Kolkhoz imeni Molotov, Semikarakor District.

Infection of wheat by leaf rust in the damp year of 1952 was not over 20% by the scale [po shkale], and in the dry year of 1953 it was even lower.

Treatment of the wheats Odesskaia 3, Melianopus 69 and Al'bidum 43 with superphosphate (7 kg/ha) and potassium chloride (8 kg/ha), diluted in 100 liters of water when sprayed from an airplane (1953) and in 400 liters when applied with a surface apparatus, was conducted as the rust appeared and developed during the heading phase and the ripening of the wheat grain. As a result of the treatment on irrigated as well as on unirrigated plots, leaf rust infection of wheat decreased by 3--9 times, the yield rose, and the specific weight of grain under irrigation increased by 12% and without irrigation by 2%.

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When winter wheat without irrigation was given supplementary food in the phase of heading, its infection comprised 49.0%, and under irrigation 63%; when it was fed supplementarily in the phase of heading and ripening of the grain, infection decreased to 33 and 11% respectively.

Rust, as a rule, appears on plants in the phase of heading, hence it can be assumed that better results could be obtained if supplementary feeding were begun at an earlier stage of development.

A one-time supplementary foliar feeding with mineral fertilizers in the same doses was carried out on spring wheat at the end of its flowering season.

In case rust infection of plants was negligible, then it was difficult to determine the influence of supplementary feeding upon the decrease of infection on the main stems. On unproductive stems, however, rust infection under irrigation decreased by almost 5 times and without irrigation by 1.5 times.

On the kolkhoz imeni Molotova, Semikarakor District, supplementary foliar feeding with potassium salts and phosphorus concomitantly with an application of a herbicide was carried out at the time of plant booting.

Even under the unfavorable arid conditions of 1958, supplementary foliar feeding produced positive results: plant infection comprised 0.01%, while that on controls was 0.7%, with practically all leaves attacked.

The positive action of supplementary foliar feeding permits the recommendation that this method which promotes productivity and reduces rust diseases be tested extensively, especially in the zones of irrigated agriculture.

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Ratner, E. I.

Mineral'noe pitanie rastenii i poglotitel'naia sposobnost' pochv.

[Mineral nutrition of plants and absorptive capacity of soils].

Moskva, Izdatel'stvo Akademii Nauk SSSR, 1950. 518p. 465.34 R182

(In Russian)

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Conclusions [of Ch. 2] (p. 106-108)

1. The problem of availiability to the plants of adsorptively fixed nutritive substances, cations in particular, does not have one single solution.

The plant roots in the process of absorption of mineral substances from the soil must overcome the ability of soil colloids to absorb and fix these same substances. If the level of saturation of the soil with one or the other nutritive substance is fairly high, the stability of the bond of this substance with the colloidal complex of the soil is relatively low, and the plants have no difficulty in the absorption of this substance from the soil. Under such circumstances the adsorptionally fixed nutritive substances, cations in particular, can sometimes become an even more favorable source of nutrition for plants, than are the soluble salts, especially at increased doses of nutritive values.

2. As the rate of saturation of the soil by one or another cation is lowered its availability to the plants falls; a rate of this fall is expressed differently for various cations, depending on the stability of their bond with the colloidal complex of the soil, which in its turn is conditioned by the nature of cations themselves, and by peculiarities of the colloidal complex of the soil, of its mineralogical composition, its wealth in organic matter, and so on.

One of the deciding factors, influencing the availability to the plants of exchange cations of the soil, is the composition of the accompanying exchange cations. In their influence on the suppression

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of availability to the plants of a given exchange cation (Begin p. 107) separate cations, which are ordinarily met in the soil, are placed in a series thus: H(Al)<Ca<Mg<K<Na.

Each cation in this series strongly depresses the availability to the plants of cations, standing before it, and weakly influences the availability to them of cations which are situated behind it in the series.

5. A special place in suppression of availability to the plants of other exchange cations is occupied by exchangeable sodium; this matches the least stability of its bond with the colloidal complex of the soil compared to other exchangeable cations (calcium, potassium, magnesium). In consequence of these peculiarities of sodium the properties of soil, as an antagonist of plants in fixing and retention of cations which are necessary for the feeding of plants, are shown especially sharp during a high saturation of the soil by sodium. The sharper is the difference in the stability of the bond with the soil between sodium and another given cation, the stronger will be expressed the suppression of availability to the plants of this last one under the influence of sodium.

In consequence of this the suppression of availability to the plants of exchangeable calcium under the influence of exchangeable sodium, as an accompanying cation, is expressed more strongly than the suppression by it of availability of exchangeable potassium.

4. Influence of the composition of accompanying exchangeable cations on the availability to the plants of a given exchange cation cannot be explained, when following the usual ideas about the antagonism of

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bases during their absorption by the roots from water solution. The nature of this phenomenon can be understood only when taking into account the importance of the soil "as an intermediary in the feeding of plants" (Vil'iams, 1947). Individual cations, as companions to calcium and potassium in colloidal complex of the soil are placed in the series not according to their antagonistical action in the solution, but according to their influence on the change of properties of the colloidal complex of the soil as a rival to the plant in fixing and retaining of these cations.

5. It is important to note the fact, which characterises the interrelations of plants with the colloids of soils and which was ascertained many times in the work, that, after certain limits of soil's saturation with sodium, other exchange cations (calcium, potassium) become quite unavailable to the plants (a critical level of saturation). With a further increase in the contents of exchange sodium in the soil there is noted a change of direction of the other cations (Ca, K, Mg): not from the soil into the plant, but from the plant into the soil (desorption of cations by the soil from plants). Desorption of cations from plants is sharply expressed in the roots and much weaker in overground organs.

6. The process of cation exchange between the plants and the soil lies as a basis of desorption of cations by soil from the plants. In favor of such treatment of the nature (Begin p. 108) of the phenomenon under consideration speaks the fact, discovered in the work, of conjunction in the plant, during the process of a transitory (56 hrs) interaction of roots with the soil suspension, which is highly saturated with sodium, of two oppositely directed cation streams:

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one consisting of ions of Ca, K and Mg and directed from the plant into the soil, and the other, consisting of sodium ions and directed from the soil into the plant.

Corresponding to the physico-chemical nature of this process, desorption of cations from the roots proceeds with greater rapidity. Involving of overground organs into this process occurs only later, after a sharp disturbance of the initial composition of cations in the roots.

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Conclusions [of Ch. 3] (p. 148-150)

1. At a lowering of the level of provision of plants with elements of mineral nutrition, with cations in particular, the contents of the same in overground organs (leaves) are being sustained on a much higher level than in the roots, which fact is achieved through a full deplition of the root system in relation to these cations. On the other hand, desorption of cations from plants (Begin p. 149) by the colloids of the soil proceeds also much stronger from the roots, as compared to overground organs. All this speaks about a weak retentive ability of the roots in relation to cations, contained in them.

2. Direction of movement of cations in a system, plant - soil, is determined not only by a rate of saturation and the stability of a bond of the given cation in the soil, but in no smaller measure also by a saturation rate of plant tissues, especially of its root system, with this cation.

The more a plant is saturated with a given cation, the higher becomes that critical level of saturation of the soil with it above which the movement of cations is guaranteed from the soil into the plant, and below which the movement of the cation changes its direction (desorption of the cation by the soil from the plants).

3. The high activity of plants in absorption of exchange potassium from the soil, however, has its limits during a decrease of the rate of saturation of the plant with this cation. During a very intensive and long potassium starvation, which leads to a sharp disturbance of physiological processes in a plant, the activity

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of its absorption of exchange potassium from the soil does not increase, but rather decreases.

4. During a high saturation of the soil with exchange sodium, properties of the colloidal complex of the soil, as an antagonist of plants in fixing other cations, is expressed so sharply, that desorption by the soil of calcium and potassium from plants occurs even from tissues which are weakly saturated with these cations.

Here too desorption of calcium and potassium is much stronger expressed in roots, regardless of the fact that, with a deficiency of potassium in plants the roots are already highly exhausted by overground organs.

6. A weak ability of the roots to withstand desorption of mineral substances by the overground organs, as well as by the colloids of the soil, creates certain difficulties for the root system, when it tries to carry out its functions as an organ of supply of elements of mineral nutrition for the plant. Surmounting these difficulties, as it was already mentioned by us previously, is achieved by the fact that during a low provision of the soil with elements of mineral nutrition the saturation of the adsorptive apparatus of root cells is maintained at an extremely low rate, owing to the extraction by overground organs of mineral substances from the root. This provides a high activity of the roots in absorption of adsorptively fixed nutritive substances. In view of the above, the growth of the plant, which is tied to a continuous extraction from the root system of mineral substances, which are utilized for the formation of new tissue and organs, is the most important factor, determining the activity of the

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plant in its interrelation with the solid phase of the soil.
(Begin p. 150)

6. Age and phase changes, deeply influencing the "quantitative ratio of an organ to the conditions of its life" (Vil'iams), bring basic changes also into the activity of the plant in its interaction with the colloids of the soil.

The aging of the plants, particularly their entering into the reproductive phase of their development, is characterized by a sharp fall of their activity in the absorption of exchange cations of the soil, especially under conditions of the growing solidity of the bond of these cations with the colloidal complex of the soil.

At that negligible rate of soil saturation with potassium, which is usually found in natural conditions, the exchange potassium of the soil can only be counted as a real source of potassium for the plants up to their entrance into the reproductive phase of development. In later phases of the plant development this source of potassium becomes for them but very difficultly available.

Consequently, this question about methods for determination of potassium which is available to the plants and of ways to influence the conditions of potassium nutrition for the plants cannot be solved separately from ontogenetic changes in the activity of the plant during its interaction with the solid phase of the soil.

7. Besides the age and phase changes, the activity of the plants in the absorption of exchange cations undergoes substantial changes also under the influence of the surroundings. The influence of water starvation can serve as an example of such an effect of an outside

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agent. The plants which suffered a short water starvation (wilting) sharply lowered their ability to counteract the bond of exchange potassium with the colloidal complex of soil.

8. Distribution of water in different organs of plants under conditions of water deficiency proceeds in the same direction as does the distribution of mineral substances at their scarcity in the surrounding area. In the one and the other cases it is the root system which becomes the most depleted because of the transfer of water, as well as of mineral substances, into the overground organs (leaves). That is why water starvation in plants tells first of all in the root system, which leads to the lowering of the absorptive activity of the roots.

9. There are no critical zones or levels of saturation of the soil with nutritive substances without a reference to the condition of the plant. The state of the critical level depends not only on the properties of the soil, but also, to a smaller degree, on the condition of the plant, its activity in the interaction with the solid phase of the soil.

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p. 164-179 (part of Ch. 4)

2. Contact exchange and surface migration of ions.

As it was pointed out in chapter I (introductory) the idea about direct reaction of colloids of plant root cells and colloids of the soil has developed parallel to the development of our knowledge of the mechanism of absorption of mineral substances by the plants from the outer medium and of the role of adsorptive processes in this mechanism.

However, this trend received a special development in works of H. Jenny; on the basis of principles, which were introduced by him about the contact exhhange and the surface migration of ions, he made an attempt to base theoretically and experimentally the possibility of direct (contact) exchange by ions between soil colloids and cell colloids of plant roots (Jenny and Overstreet, 1939; Jenny and Ayers, 1939; Jenny, Overstreet and Ayers, 1939; Elgabaly, Jenny and Overstreet, 1943).

In a still earlier work by Jenny and Cowan (1939) they succeeded to show that soy-bean shoots extract absorbed calcium from Ca-clay, exchanging it for hydrogen whereupon (Begin p. 165) the exchange proceeds in stoichiometric proportions. From a clay suspension, saturated with calcium and having pH 6.8, the shoots extracted 1.02 meq. of calcium, lowering the reaction of the suspension to pH 4.32. During titration of this suspension with the aid of $Ca(OH)_2$ it was found that it contained 0.948 meq. of hydrogen, which was not present at the beginning of the experiment. A similar exchange of cations, absorbed by the plant from the soil, for hydrogen was also discovered in experiments by S. Dojmi di Delupis (1936).

Yet, in the cited works there was no question raised about direct exchange of ions between the root and the adsorbent. The revealed facts

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are treated from the point of view of the effect of hydrogen adsorbent on carbon dioxide released by the roots.

Further development of this problem rests on the kinetic theory of ion exchange introduced by Jenny (1936). According to this theory the adsorbed ions, which are held back by electrostatic pull to the adsorbing surface, but are in a constantly oscillating movement, which is limited for each ion by a three-dimensional area around a certain point of attraction of the given ion. This three-dimensional area composes a certain volume of vibrations ("oscillating volume"), which is different for various ions, depending on their nature.

Ion exchange between a colloid and a solution is conceived according to this theory as a result of penetration of the displacing ion from the solution into the area of the ion's vibrations, which is on the surface of the colloid. In this case the cited ions can exchange their places (Figure 11).

Developing further this idea about oscillating volumes of ions, H. Jenny and R. Overstreet (1939) introduced a conception about contact exchange, as one of the mechanisms with the aid of which a plant can absorb exchangeable cations from the soil. The authors think, that during a close contact of soil colloids and cell colloids of plant roots (as of any other two colloids, having a similar charge) volume of ion oscillations, sitting on the surface of colloids of root cells, can mutually enter into each other (see scheme of Figure 11). Under these conditions ions can as is "jump over" from one surface to the other and thus be utilized by a plant without passing through the liquid phase.

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The conception about a contact exchange is supplemented by the authors with another conception about the surface migration of ions, based upon the same principle of interpenetration of oscillation volumes of adjoining ions. The difference here is in the fact, that in this case the question already is about ions, sitting not on different adsorbing surfaces, but next to each other on the same surface (see scheme of Fig. 11).

(Begin p. 166)

Contact exchange and surface migration of ions is treated by the authors as two phenomena, which supplement each other and together explain the possibility of exchange and the movement of ions in two colloidal systems which are in contact without the participation of the liquid phase.

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Title of Figure 11. Scheme of ion exchange according to Jenny and Overstreet.
1 - scheme of ion exchange between the colloid particle and the solution; 2 - scheme of contact exchange between two colloid particals; 3 - scheme of contact exchange, 4 - scheme of contact displacement; 5 - scheme of surface migration of ions.

Legend in the figure proper:
1-colloidal particle
2-colloidal particle - colloidal particle
3-root - clay particle
4-root - clay particle

(Begin p. 167)

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Jenny and Overstreet conducted a series of model experiments and experiments with plants for the illustration of ideas developed by them.

Thus, for instance, when putting on the bottom of a test tube a gel of Fe-H-bentonite, and over it (without mixing) a gel Na-bentonite, the authors found in a week's time that iron penetrated from Fe-H-bentonite into Na-bentonite, while Na from Na-bentonite penetrated into Fe-H-bentonite. Meanwhile such exchange of ions was not found when both bentonites were separated from each other by a thin layer of water. In a similar manner, when separating Fe-H-bentonite and H-bentonite by a very thin collodion membrane, which in the opinion of the authors, mechanically retains in its minute pores the finest particles of clay, a migration of iron into H-bentonite takes place; yet, if these gels are divided by two such membranes, between which there is a thin layer of water, no migration of iron is then seen. All this, in the opinion of the authors, conforms to the idea of contact exchange and surface migration of the ions.

The idea about surface migration of ions is, in our opinion, the most productive and justified part of Jenny and Overstreet's conception. It explains the possibility of contact absorption by plants of adsorbed ions not only from that part of the surface of colloidal micelle which is turned to the root hair and comes in direct contact with it, but also from the opposite, and even from the inner (in case of colloids with intermicellar exchange) parts of its surface, as well as from further removed colloidal particles, which are not in direct contact with root hairs.

Without a surface migration of ions a contact between roots and soil particles could not play any substantial role in the absorption by plants of adsorbtively held nutrients.

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Actually, even the latest researches about the power of development of root systems give such dimensions to the surface of the roots, which in comparison with dimensions of soil particles are so small, that counting direct contact alone, without a possibility of surface migration of ions, the plants could assimilate only a negligible part of the cations from the soil, actually absorbed by them. M. A. Egorov (1936) was the first to point out this circumstance: the relatively insignificant dimension of the surface of active part of the root system compared to the surface of soil particles in the layer of soil where the roots are found, as a substantial difficulty in the utilisation by the plant of effective fertility of the soil. Still more impressive data on this problem are given in the work by N. I. Savinov and N. A. Pankova (1942) which calculated, that the overall surface (Begin p. 168) of the whole root system (including the root hairs for the Festuca sulcata - pyrethrum plant group on chestnut soil on the left bank of Volga, studied by them, constitutes for a layer of soil 1 m. in depth only 1/266000 part of the total surface of all soil particles in the same volume of soil, calculated according to Mitcherlich. If one proceeds from the cited data of Savinova and Pankova, then, in a case taken by them, the satisfaction of calcium(1) needs of plants at the expense of exchangeable calcium of that part of soil particles, which come in direct contact with the root system, can guarantee only a very small part of the amount of cations, which are actually drawn out by the plants from the soil (according to our calculations only about 500 g (!) Ca per ha, when computing the weight of a one meter layer of soil as 15 mln. kg, and contents of exchangeable calcium 26 meg-v per 100 g of soil).

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(1) The same refers to potassium but in a still sharper degree.

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One should note, however, that a thesis developed by H. Jenny and R. Overstreet, and which is supported by many foreign researchers, that the movement and exchange of ions among colloidal parts can proceed only as a result of contact exchange, seems to us onesided. In the work of I. N. Antipova - Karataeva and V. I. Filippova (1939), as yet before the appearance of works by Jenny and Overstreet, it was shown quite convincingly that practically a full alignment of the composition of exchange cations in adjacent samples of the soils and clays studied by them, saturated with various cations, can be achieved with a continuous reaction (2 months), even in that case when these samples are separated by a cellophane partition, and, consequently, do not come in direct contact. I. Koller (1937) also pointed to the possibility of cation exchange between adsorbents through the medium of the liquid phase on a basis of his experiments with samples of natrolite, which was saturated with different cations. Finally, the experiments by Jenny and Overstreet cited above essentially speak about the same when they separated the bentonite clays with a collodion membrane. An attempt by the authors to explain this by the fact that a very thin collodion membrane retains in its minute pores the finest particles of clay, and, consequently, does not interrupt a contact between samples on both its sides; this is not very convincing to our point of view. The matter is, that the evidence on which this explanation is based--absence of ion exchange between variously saturated samples of clay, when they were separated not by one, but by two collodion membranes between which there was a thin layer of water--speaks only about the fact that under these conditions diffusion of ions was very hampered (Begin p. 169) and could not

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come through under conditions of a reaction of short duration (20 hrs. instead of two months in the experiment of I. N. Antipova - Karataeva and V. N. Filippova).

Experiments by Jenny and Overstreet tell only that under conditions, which allow a contact exchange, migration of cations from one colloidal system into the other proceeds much faster, than in the case of migration through a solution - a diffusion.

In spite of this stipulation, we suppose that under natural conditions the surface migration of ions is a very important factor, which makes possible the comparatively fast movement of adsorbed ions in the soil to the point of reaction of the colloidal particle withthe root hair.

What concerns the second part of Jenny and Overstreet's conception, namely the contact exchange in that form in which it is offered by the authors and in their evaluation, adapting it to the case of reaction of roots with soil colloids, this arouses many objections.

First of all, the notion about spontaneous "jumping" of ions from the surface of soil colloids to the surface of colloids of root hairs with a full elimination of participation of the liquid phase in this process, is hard to reconcile with concrete conditions of plant growth in the soil.

As A. F. Tiulin correctly points out: "in the process of plant feeding it is impossible to imagine either a dry root hair of a plant, or a dry soil colloid. Both have, in an active state, water films of one or another capacity" (1936, p. 7). But if one accepts, that root hairs are separated from soil particles by water films, then it is hard to imagine such their close rapprochement during which the volumes of oscillations of ions, sitting on the surface of soil colloids and of colloids of root cells, could

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as easily enter into each other, as in the case of ions sitting side by side on the same surface (surface migration of ions). Hence it is necessary to assume that a contact exchange of ions between the plant roots and soil colloids must occur in any case with participation of the liquid phase, which enters as a component part into the closed system of the soil colloid - the root hair. This liquid phase, as we saw it previously, cannot be identified with soil solution in the usual understanding of this term, that is with the free water. S. Mattson (1938) states that it is necessary to distinguish two forms of soil solutions. Micellar solution is a composite part of the micelle. Attempts to separate this solution by pressure or some other way do not achieve their aim. A peculiarity of this micellar solution, from the point of view that interests us, is a content in it of ions which are dissociated by the colloidal particle, and which are held at the surface of the colloidal particle by (Begin p. 170) electrostatic forces of attraction of the latter. The nature of contact absorption is conceived by us primarily in the fact, that at a close bond of root hair with soil colloids the plant can by its water films, with the aid of exchange reactions, absorb selectively the nutritive ions directly from the micellar solution, without their previous passage into the soil solution. With an interpretation, thus stated by us, of the essence of contact absorption, it is obvious, that the advantage of this type of absorption before the absorption from intermicellar liquid must be especially noticeable in case of weak saturation of the colloid by the given ion, when its concentration in intermicellar liquid is especially low.

One should note that the explanation of the mechanism of contact exchange, proposed by Jenny and Overstreet, which excludes a participation of the

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liquid phase in this process, probably does not satisfy the authors themselves. We will judge about this on the basis of Overstreet's (1945) work, which recently appeared, in which the contact exchange is identified by the author with the suspension effect of G. Wiegner and Pallmann (a different value of pH in the colloid suspension, in its ultrafiltrate or centrifugation). Essentially, this speaks in favor of the above cited interpretation of the mechanism of contact exchange because the suspension effect according to Wiegner and Pallmann, is also a result of the fact that in the suspension of the colloid, in contrast to its ultrafiltrate or centrifugation, not only the free ions of hydrogen (or hydroxyl-ions) of the intermicellar liquid, but also, partly, ions, which are yet in bond with the micelle, are active.

Another objection against the recognition of the mechanism of contact exchange is presented in a work by G. Lundegardh (1942).

Developing the electrochemical conception of interrelations in the absorption of substances between the root system and the soil, this author points out that cellulose walls of the epidermis and of root hairs, although very thin, they yet form an electrically neutral partition, which separates the surface of protoplasm from soil colloids. Therefore nutritive ions, absorbed by the soil before they can be absorbed by the living protoplasm, must be separated from the surface of soil colloids and pass through cell walls, which are saturated with water. Thus, in Lundegardh's opinion the contact absorption generally cannot take place, because between the adsorbing surface of the protoplasm and the soil colloids there cannot be any direct contact on account of the presence of cell membrane. It seems to us that at the present time it is quite

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impossible to justify the overlooking of the role of cell membranes in the absorption of mineral substances by root cells. (Begin p. 171)

The role of cell membranes in the phenomena of absorption during reaction of a plant cell with the outer solution was stressed yet by Pfeffer (1886) in his well-known works on absorption of dyes. Although, later on, this role of cell membranes was for a long time ignored by researchers as all the attention in this respect was shifted to the protoplasm, yet the later works by S. Strugger (1935) and A. Czaya (1936) do not leave any doubt, that the cell membrane is the first organized system of the absorbing cell, which comes into cooperation with the outer medium. In this system is accomplished the absorbtive accumulation and further absorption of substances by the cell. Even the fact that S. Brooks (1938) in his works on studies on distribution of radioactive potassium among the membrane, the protoplasm and the vacuole did not find any noticeable accumulation of it in the membrane does not tell anything against participation of the latter one in the primary adsorptive fixation of substances from the outer medium. In the same Strugger's work (1935) it is shown by demonstrative experiments how unstable this bond of adsorbed substances with the membrane can be, and how fast, depending on pH of the medium, the age of the cell, and even on the peculiarities of different parts of the membrane of the root hair, can the adsorbed substance move from the cell membrane into the protoplasm, into the vacuole or into the basal part of the membrane of the root hair, which directly adjoins the root tissue.

In Strugger's opinion, the plasm and the membrane must be considered as a biological whole, as the internal layers of the membrane are pierced intermicellarly by the living plasm. D. A. Sabinin (1940) also points this

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out. In connection with this let us recall the role of plasmodesmas, which were discovered yet in 1877 by I. N. Gorazhankin, which pierce the cell membranes and link the whole living protoplasm of the plant into one whole.

Thus, the point of view of Lundegardh, who denies the role of cell membrane in the primary adsorbtive fixing of substances from outer medium, must be held absolutely baseless and not answering the modern state of knowledge in this field.

We thought it was necessary to speak about Lundegardh's views because if they were correct, then the formulation of the question itself about the contact absorption of substances by plants as a result of direct reaction between adsorptive surfaces of colloids of root cells and of soil colloids would not have any basis, regardless of interpretation of the nature of this reaction.

Turning, further on, to an examination of the experimental material in Jenny's works, on which he bases the evaluation of (Begin p. 172) the role and importance of contact exchange during reaction of roots with soil colloids, it is necessary to point, that this material reflects the purely physico-chemical approach of the author to the solving of a problem which interests us. Such an approach cannot satisfy a biologist because colloidal-chemical properties of a plant cell by no means are the sole factors, which determine the exchange of mineral substances between the plant roots and the soil colloids. Intensiveness and direction of processes of metabolism in live cells, on which depend the activities of plants in the absorption of mineral substances from the outer medium, are here the deciding factors.

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Ignoring this circumstance and operating with living, and metabolically active, roots of barley as with a dead colloidal adsorbent brought the authors to several faulty conclusions and to revaluation of the role of contact exchange with the reaction of roots with the soil.

We will allow ourselves to illustrate this idea by several examples citing, on the one hand, experiments by Jenny, and on the other one, our own researches.

The basic experiments, on which Jenny and Overstreet's representations are based about the role of contact exchange during the reaction of plant roots with soil colloids, are experiments with desorption of potassium from barley roots at their reaction with suspensions of colloidal clays or soil colloids, which are saturated with other cations (hydrogen, sodium, calcium, strontium, barium). The authors have found out, that desorption of potassium from the roots is precisely characteristic for colloids saturated with the cited cations, and does not appear, or appears very weakly, in a case of soluble salts with the same cations.

This was made apparent very prominently in experiments when radioactive potassium was driven out from the roots (Jenny, Overstreet and Ayers, 1939).

Let us cite some of these experiments. In one of them the three week old barley, containing radioactive potassium, which it absorbed from the culture medium on which it was propagated, was placed for 55 hours by its roots: in one case in a suspension of colloidal clay, saturated with sodium, and in another one - into solution NaCl, containing a similar amount of sodium.

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After 53 hours the rate of desorption of radioactive potassium from the roots was evaluated by the radioactivity of experimental mediums (suspension and solution). In the solution NaCl radioactive potassium was not found, whereas in the suspension of Na-clay it was found in a considerable amount (606 counts per minute on a Geiger counter for 25 cc of suspension).

In another experiment, in which the reaction of roots with (Begin p. 178) culture mediums continued for 3.7 hours, displacement of radioactive potassium from the roots by suspensions of the same colloidal clay, saturated with magnesium, calcium, strontium, barium and corresponding solutions of chlorides of these cations.

Displacement of radioactive potassium from the roots was expressed by the following values (readings on Geiger counter per minute for 25 cc of liquid).

Mg - clay -- 109 ± 6.4	$MgCl_2$ - 3.3 ± 4.1
Ca - clay -- 66.3 ± 3.8	$CaCl_2$ - 11.3 ± 3.7
Sr - clay -- 68.4 ± 6.8	$SrCl_2$ - 13.6 ± 4.6
Ba - clay -- 45.2 ± 4.8	$BaCl_2$ - 2.8 ± 3.6

Here also a displacement of potassium by soluble salts is negligible, and usually lies in the limits of an error of the method, whereas its displacement by corresponding colloids is above doubt.

Similar or related data were obtained in many other experiments, as with severed roots so also with whole plants, from which the authors made conclusions, that desorption of cations from roots is basically characteristic to colloids, but not to solutions, - is a conclusion, which seems, not without basis, to some researchers "mysterious" (Peterburgskii, 1942).

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Yet with a closer analysis this "mysteriousness" can be easily deciphered. It issues from a purely physico-chemical interpretation by the authors of phenomena observed by them without taking into consideration, that one of the reacting components in their experiments was a live, metabolically active organ of the plant - the root.

Actually, the authors grew the plants for their experiments according to a carefully worked out method by Hoagland and Broyer (1936) when plants are obtained which have a very pronounced ability for potassium absorption from the outer medium, under conditions of aerobic metabolism. Not only the whole plants, but the severed roots of these plants also, which were placed into a solution, containing potassium, have often doubled and tripled during experiments by Hoagland, and his co-workers, the contents of potassium during the course of a short time - 10 hours.

From here such a sharp difference in the influence of colloids and soluble salts on desorption of radioactive potassium from roots in the above cited experiments becomes understandable: at that length of time for experiments, which was used by authors, radioactive potassium, which was displaced from the roots by cations of soluble salts had time, before the end of the experiment, to be fully, or almost fully, reabsorbed by the plants, whereas in the colloidal suspension (Begin p. 174) this potassium was retained by the adsorbent and could only partly be reabsorbed by the roots, depending on the permanence of its bond with the adsorbent.

By this circumstance can also be explained the other fact, which remained incomprehensible and unexplained by the authors that, in contradistinction to solution NaCl, the solution KCl displaced radioactive potassium from roots as energetically as suspension of K - clay did.

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Thus, for the 53 hour period of reaction the following data were obtained (reading on Geiger counter in 1 min.):

Na - clay -- 606 ± 93 NaCl - 0

K - clay -- 374 ± 60 KCl - 314 ± 69

It is necessary to explain this fact issuing from a circumstance, that during the displacement of radioactive potassium from the roots by non-radioactive isotope the plants were saturated by potassium at the latter's expense in consequence of which the displaced radioactive potassium remained in the outer medium and was not reabsorbed by the plant.

To illustrate the correctness of the cited interpretation of Jenny's experiments let us give results of some of our own researches in this direction.

Our experiments were conducted with barley, variety Viner 1165, which was grown in water cultures with Helrigel's solution, which was prepared with water from the water supply line, and was taken for the experiment when 15 days old. Before this the culture medium was changed twice.

The plants, after their roots were carefully washed by distilled water, in order to remove all culture medium, were placed by their roots into the following mediums: a) distilled water (800 cm^3); b) solution of NaCl, containing in 800 cm^3 10 m - egv. of Na; c) suspension of red earth soil (100 g per 800 cm^3 of water), containing among the exchangeable cations (after appropriate processings) 10 m-megv. Na, 5.6 m-megv. Ca and 5.9 m-megv. Mg at a pH of the suspension about 7.2. For each vessel 50 carefully selected plants, similar in outer appearance, were taken; experiment was in double replication.

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Two series of experiments were conducted. In one the reaction of roots with the cited mediums continued for only 3 minutes (more correctly from 3 to 5 min.), after which the roots were immediately washed with distilled water and the aboveground organs were severed from the roots; both of these were then dried, weighed and under-went analysis. In the other series the reaction of roots with the cited mediums continued for 23 hours with a systematic aeration every hour for 10-15 min. (with an interruption for the night). (Begin p. 175)

Table 64 gives results of the first series of the experiment.

Table 64

Desorption of potassium from plants during reaction of roots with NaCl solution and a suspension of the soil in the course of 3 minutes.

Variants of experiments	Dry weight of plants in g per vessel		Contents of potassium in plants in mg per vessel		
	roots	above-ground	in roots	in above-ground organs	Total
Plants put for 3 min: into distilled water (control)	0.78	2.20	21.1	110.6	131.6
into solution NaCl	0.80	2.29	16.4	109.3	125.7
into soil suspension	0.81	2.31	13.7	110.8	124.5

From an analysis of the table it is seen that already a three minute reaction with the soil suspension is quite sufficient for a clearly expressed desorption of potassium from roots. Nevertheless, as it should have been expected, on the basis of regularities of the ion exchange, the same effect,

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although in a less sharply expressed degree, is also detected in the case of the solution of sodium chloride.

The fact, that in the latter case displacement of potassium from roots is expressed less sharply, than in a case of soil suspension, appears also to be regular, because in the solution of NaCl the acceptor is absent, which is able to a considerable degree to remove the desorpted potassium from the sphere of reaction, as it takes place in the case of soil colloids, which are highly saturated with sodium, where potassium, which was desorpted from plants was driven back by more hydrated sodium ions into the inner layer of the "swarm" of ions.

In any case, with such an arrangement of the experiment, desorption of potassium from roots by the NaCl solution and by Na - soil suspension is expressed by values of one and the same order and does not include anything mysterious.

Let us now turn to results of the 2nd series of experiments which are given in table 65.

From data given in the table it is seen, that in the case of plants, which were placed into NaCl solution, as well as in the case of plants which were put into distilled water we find during the experimental period only a small shifting of potassium from the root into aboveground organs, which continued to grow intensively and during 23 hours showed an increase in weight of 17-20%. Thus, plants (sentence continues on page 176, after table 65) (Begin p. 176)

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Table 65

Desorption of potassium from plants during reaction of roots with NaCl solution and with suspension of soil during a period of 23 hours.

Variants of evaluations	Dry weight of plants			Contents of potassium in mg. per vessel			Potassium desorbed from plants in mg
	roots in g per vessel	Aboveground organs		in roots	in overground organs	Total	
		in g per vessel	in % form control				
Before the experiment (control)*	0.78	2.20	100	21.1	110.5	131.6	—
After placing for 23 hrs. in: distilled water	0.78	2.64	120	16.7	117.9	134.6	+ 3.0
NaCl solution	0.79	2.59	117	15.2	117.7	130.9	- 0.7
soil suspension	0.79	2.63	120	11.7	101.0	112.7	- 18.9

* For this variant data was taken from the preceding table for plants which were placed for 3 min. into distilled water.

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had time to reabsorb also that potassium, which was forced out from the roots during the first minutes of their reaction with NaCl solution. The absorbing activity of the young, metabolically active shoots was found to be a much more powerful factor than the desorptive activity of Na ion from the NaCl solution.

We have a quite different picture with the reaction of roots with soil colloids. In this case the analysis reveals loss of potassium not only by roots, but also by overground organs, regardless of the simultaneously proceeding intensive growth of this organ. In other words, with this comparatively high saturation of the plant with potassium, which had a place during the experiment, soil colloids, which were highly saturated with sodium came forward as a much higher acceptor of potassium, than the plant.

These are the conditions under which is formed the apparent basis for that conclusion to which H. Jenny, R. Overstreet and A. Ayers arrived, that the exchange ion between the roots and the outside medium, leading to desorption of potassium from plants, takes place only during reaction of roots with the colloid suspension, but not with salt solutions.

Our experiments were conducted with whole plants, nevertheless conclusions issuing from them can be adapted also to experiments with severed (Begin p. 177) roots, because roots of barley, which were grown according to method of D. Hoagland and T. Broyer, as was pointed out, have a sharply expressed peculiarity of potassium absorption from the outer medium under conditions of aerobic metabolism. However, confirmation to this can be found also in the work of Jenny and Overstreet (1939) itself, from which it is apparent that severed roots of barley, when placed into KCl solution for 10 hours, have during this time doubled the amount of

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potassium contained in them.

One should add, that in certain cases, with a sharply lowered ability by the plants to absorb a given cation from the outer medium, as a result of either a high saturation with it of the plant tissues, or in consequence of growth changes in the organism, desorption of this cation from the roots by another cation from the solution (let us say, the same sodium cation) can proceed in considerable amounts even under conditions of a longer reaction, sometimes in similar ones, as also in the case of soil suspension, saturated with sodium.

Data of one of our experiments with barley can serve as an illustration of this, when barley was grown on Helrigel's solution and it was taken for the experiment during the phase of the beginning of formation of seeds. During the period of preliminary growing of plants the culture medium was changed three times.

The plants were placed by their roots for 48 hours: in one case into distilled water, in another case - into a suspension of red earth soil, saturated with sodium, and in a thrid case - into NaCl solution where sodium content was equivalent to its content in soil suspension (30 meg per 1200 cc of solution). Replication of the experiment was six-fold.

Results of the analysis of roots on the content in them of calcium and potassium are given in table 66.

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Desorption of calcium and potassium from the roots of barley by soil suspension ~~of~~ saturated with sodium and by NaCl solution.

Variants of evaluations	Dry weight of roots in g per vessel	Contents of calcium		Contents of potassium		Desorbed in % from the control	
		in %	in mg per vessel	in %	in mg per vessel	Ca	K
Plants, placed for 48 hrs: into distilled water (control)	1.09	5.62	38.57	0.78	8.60	---	---
in soil suspension	1.05	1.39	14.52	0.41	4.22	61	47
in NaCl solution	1.01	2.54	25.65	0.44	4.44	28	44

(Begin p. 178)

As seen from the examination of the table, and in the case of NaCl solution desorption of calcium and of potassium from the roots is expressed at a highly sharp rate, in respect to potassium almost to the same degree as in the case of soil suspension.

It seems to us that the cited examples are quite sufficient in order to show, that Jenny's idea about contact exchange, notwithstanding their important meaning for an understanding of those processes, which proceed in the closed system of the root hair - the soil particle, yet need substantial corrections, for the most part issuing from our knowledge about the root system as an absorbing organ.

Jenny's ideas are developed mainly on a basis of experiments, ascertaining phenomena of cation desorption from roots. Exactly this phenomenon, which was uncovered already in our first experiments, given in Chapter II,

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has drawn our attention, long before the appearance of works by H. Jenny, because it testified about the presence between the roots and the soil colloids of a certain kind of reaction, which did not confine itself to the usual ideas about the soil solution as an intermediary between plant roots and soil colloids. Undoubtedly, desorption of cations from plants during the reaction of roots with soil colloids must be, if not fully then fundamentally, reduced to contact exchange in the above-cited interpretation.

Nevertheless, when we pass over to a reverse process - desorption by a plant of exchangeable cations from the soil - here the matter is much more complicated. Here the contact exchange can become only one of many factors influencing the availability to the plants of adsorptively held nutritive substances.

Meanwhile, after the appearance of H. Jenny's works, the contact exchange is often interpreted by foreign researchers as a basic, if not the single, mechanism, with the aid of which the adsorptively held nutrients are being used both by higher plants, and also by microorganisms.

An unbiased evaluation of the role of contact exchange in the general mechanism of absorption by plants of adsorptively held nutrients can only be given on a basis of experiments with plants. Here, more than anywhere else, it is necessary, in Zh. Bussengo's expression, "to ask the plant its own opinion".

In this respect to us the experiments by H. Jenny and A. Ayers (1939) seem hardly convincing; experiments where absorption by the roots of potassium, adsorbed on colloidal clay, was compared with absorption of it by carbon dioxide during a single, although a prolonged, treatment (10 days).

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The absorptive activity of the plant constantly disturbs those extremely dynamic balances, which are established (Begin p. 179) between the colloidal complex of the soil and the soil solution. The activity of root secretions, of carbon dioxide in particular, is not an episodical, but a constantly acting factor. Further on, as we saw, carbon dioxide is not, by far, the single agent among root secretions, with the aid of which the plant can influence the colloidal complex of the soil.

Finally, the contact absorption, which is accomplished in a closed system of root hair - soil particle, must be considered as a wider understanding about an active reaction of plants of the colloidal complex of soil, than just contact exchange; we tried to demonstrate this in the foregoing section.

Issuing from these considerations, beginning with 1940, we undertook certain researches on studies of relative importance of contact exchange in the general mechanism of absorption by the plants of adsorptively held nutrients.

We proceed now to set forth these researches.

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p. 179-197 (part of Ch. 4)

3. Role of contact exchange during absorption by the plants of adsorptively fixed cations.

Into the problem of our researches entered an explanation of the role of contact exchange under such conditions, when on the one hand the influence of root secretions would be fully preserved as a systematically acting factor, and on the other hand, a possibility of localization of secretions in a closed system root hair - colloidal part would be excluded. Realization of these conditions was achieved by the following technique of conducting our experiments.

The plants were grown according to methods of isolated feeding (variant of water - sand cultures), which was developed in the laboratory of Academician D.N. Prianishnikov and underwent with us some changes. The complete nutrient solution, with the exclusion of the studied element, was put into the outer vessel (sand). The element of the mineral nutrition, which was under study, and which was absorbed on one or another adsorbent, was added in a form of water suspension of this adsorbent into the inner vessel (water). Also in one case the adsorbent was in contact with the roots, being suspended in the same liquid in which the roots were, while in another case it was isolated from the roots by a collodion membrane, which was achieved by suspending the adsorbent suspension in the liquid of an inner vessel in a collodion bag, around which the roots were placed. The collodion bag was held up (Begin p. 180) on the cover of the inner vessel with the aid of a glass funnel, to which it was attached (fig. 12).

The holding capacity of the inner vessel was 1200 cm^3, the holding capacity of the collodion bag about 200 cm^3.

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Title of figure 12. Scheme of an experiment with a double isolation
Words in the figure (top to bottom) collodion bag, water, sand, gravel.

The bags were prepared by multiple layers of the collodion in order to obtain a sufficiently solid and sturdy membrane, as well as for the prevention of a possibility of contact exchange between the roots and the adsorbent through the pores of a thin membrane.

(Begin p. 181)

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The liquid in the inner vessel, in the bag as well as outside of it, was constantly and carefully stirred by a glass rod with a rubber tip several times a day, as well as aerated twice daily. This guaranteed, on the one hand, a sufficiently fast exchange of soluble substances between the little bag and the outside liquid, and on the other hand, a constant stirring of adsorbent which made a formation of a closed system root hair - colloidal particle impossible.

Thus, with an isolation of roots from the adsorbent by a collodion membrane, the roots could absorb only those nutrients diffused from the bag which separated from the adsorbent under the influence of root secretions and under the influence of hydrolysis. In the absence of a membrane to this was added also a possibility of absorption of adsorptively held nutrients by means of contact exchange. Comparing absorption by plants of a given nutrient during the two cited variants of the experiment, it was possible to obtain an idea about the role of contact exchange in the process.

Our research into the mechanism of absorption by plants of exchangeable cations was primarily concerned with potassium.

An experiment was conducted with corn, of a variety "Belaia angliiskaia" [white, English], in 1940, according to the above cited procedure. Into the outer vessel (sand) was introduced the Prianishnikov's nutrient solution without potassium; the source of potassium was added into the inner vessel (water).

Permutite, which was prepared on Doktorovskii factory and containing a certain excess of soluble glass was taken as the adsorbent for potassium

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absorption. Permutite was washed in a filter with distilled water to free it from the excess of soluble glass, after which it was saturated with calcium by a long treatment of 0.5 N solution of calcium chloride, and then was washed with water until the disappearance of reaction to chloride.

Permutite, freed from soluble salts, and saturated with calcium, was then transferred into a large porcelain glass, filled up with a fivefold amount of 1 N solution of potassium chloride and was left for a reaction with it for two, twenty-four hour, periods with frequent stirrings. After this permutite was washed with water in a Büchner funnel until the disappearance of reaction to chloride.

Analysis of the composition of exchangeable cations in a thus obtained permutite disclosed the following content of exchangeable forms of calcium and potassium (displacement of ammonium ion from the solution of NH_4Cl): exchangeable Ca - 33.2 m - eqv per 100 g of dry matter, or 30% of exchange capacity; of exchangeable K - (Begin p. 182) 76.1 m- eqv per 100 g of dry substance, or 70 % of exchange capacity; capacity of exchange (according to a sum Ca + K) - 109.3 m - eqv per 100 g of matter.

This permutite was then introduced as a source of potassium for plants under the above cited conditions, that is, in one case in a presence of contact between the roots and the adsorbent, and in another case - at an isolation of roots by a collodion membrane.

In connection with the often met instructions that doses of potassium used in vegetation experiments are too excessive, which condition might conceal the role of the contact exchange, we lowered the potassium dose four times compared to Prianishnikov's norm, and besides this, we included into the experiment a variant with a doubled dose of potassium compared to the

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first variant. The first dose was 170 mg, and the second 340 mg of potassium per vessel which holds 8.3 kg of sand.

The corn shoots were previously grown in water from the water supply and transplanted into the vessels after eleven days of growth. Harvesting was done on 27.IX 1940, 37 days after planting.

The experiment gave the following results (tab. 67).

Table 67

Role of contact between the roots and the adsorbent during absorption by plants of exchangeable potassium

(Permutite, saturated to 30% Ca + 70% K)

Variants of the experiments	Dry weight of plants in g per vessel	Increase of weight compared to control		Contents of potassium in plants in mg per vessel	Increase of potassium compared to control	
		in g	in relative amounts		in mg	in relative amounts
Without potassium (control)	5.33	—	—	14.6	—	—
Permutite:						
in contact	17.65	12.32	100	102.9	88.3	100
in isolation	15.47	10.12	82	83.1	68.5	78
in contact, with a double dose	22.43	17.10	139	186.8	171.7	194

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When studying the table, first of all it is apparent that after the first dose of potassium the plants as yet experienced a great lack of this element. This is attested by the fact that a doubling of the potassium dose produced a considerable increase of the yield and almost a doubling of the potassium amount was absorbed by the plants. (Begin p. 183)

Yet in spite of such a great deficiency in potassium, the role of contact between roots and the adsorbent as a factor, which is able to guarantee an additional absorption by the plants of this cation from the adsorbent, is not large. It is seen from the cited table that plants, even during absence of contact between the roots and the adsorbent, were able to absorb 78% of that amount of potassium, which they absorbed in the presence of such contact.

Thus, in this experiment one cannot speak about a deciding significance of contact exchange for absorption by plants of adsorptively held potassium. A deciding role was here played by the reaction of plants with the adsorbent, by means of their root secretions which infiltrated through the collodion membrane.

In order to find out a possible role played here by carbon dioxide, as well as the role of hydrolysis in separation of exchangeable potassium from the adsorbent certain laboratory researches were conducted, which were organized in such a manner as to reproduce, as nearly as possible, those conditions which took place in the experiment with plants.

For this purpose the water suspension of permutite was hung up in similar collodion bags and in similar vessels, that were used for the vegetative experiment.

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The contents of the bags, as well as the outside liquid in the vessel was carefully stirred 6 or 7 times a day for speeding up the diffusion.

After 48 hours the outside liquid was siphoned off and replaced with fresh distilled water. Three such siphonings were made.

Analysis of the dialyzate obtained in this manner, in order to find out the content of potassium in them (after evaporation of liquid and conversion of potassium into chloride) showed its concentration at 1.19 - 1.75 mg potassium per liter. Appearance of potassium in the dialyzate should be explained by the process of hydrolysis.

After establishment of the role of hydrolysis in the mobilization of exchangeable potassium, the laboratory experiments were continued in a direction for study of a possible role of carbon dioxide in this respect. For this purpose through the outside liquid in the same vessels in the course of 48 hours a slow stream of carbon dioxide was passed through 6 - 7 times a day for 10 min; after this the liquid was drawn off and replaced with fresh distilled water, through which again a flow of carbon dioxide was passed through. Such drawings off were done three times.

Analysis of the dialyzate in this case has shown that under the influence of carbon dioxide the concentration of potassium in the outside liquid rose up to 4.53 - 5.12 mg of potassium per l.

If one takes into account, that in the experiments, cited by us in the first section of (Begin p. 184) this chapter, by various researchers the concentration of potassium of 2 - 5 mg per liter already guaranteed quite a normal development of plants, then one had to admit that in our experiment the reaction of carbon dioxide, secreted by the plants, could be a deciding factor in the mobilization of exchangeable potassium from permutite.

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The processes of hydrolysis could play here a certain, but very modest role.

Together with the above cited experiment in that same year, 1940, an experiment was conducted with corn and permutite under conditions of a short duration (only 48 hours) reaction of roots with an adsorbent. One could assume, that under these conditions the role of contact exchange, as a swiftly flowing process will show up more prominently, than under conditions of a lengthy reaction, where a slow, but regular reaction of root secretions in the end hides the role of contact exchange.

For experiments of short duration corn was first grown in water from the water supply (without introduction of salts) for a period of 17 days.

Only quite healthy plants, with well developed roots were chosen at that time, as similar as it was possible to judge from the outer appearance, by the vigor of development of aboveground organs and roots.

The plants were divided into 9 groups of 12 plants each; 3 of these groups (triple replication) went into analysis for the content of potassium before the experiment (control). The other 6 groups were planted into vessels of 3 l capacity, which contained a suspension of permutite in distilled water. The weighed portions of permutite were taken at the rate of 150 mg of potassium per vessel. In addition to this, in one variant (3 vessels) permutite was suspended in that same liquid in which the roots were, in another variant it was isolated from them in similar collodion bags as in experiments with the lengthy reaction.

As it will be evident from further experiments, with a high availability of exchangeable potassium to the plants, the presence of the collodion membrane in itself did not serve as an obstacle for absorption of potassium by the plants also under conditions of a short duration experiment (48 hrs).

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During the course of the whole experiment aeration was conducted for 5 min. every hour (with a break for the night). Besides this, in order to guarantee an interchange between the liquid in the bag and the outer liquid in the vessel, both liquids were carefully stirred with a glass rod every 1 - 1½ hrs.

After 48 hours the roots were very thoroughly washed in distilled water, the plants were dried, weighed and went into analysis for the content of potassium. (Begin p. 185)

Results of the experiment are given in table 68.

Table 68

Role of contact between roots and the adsorbent during plants' absorption of exchangeable potassium under conditions of a short reaction (48 hrs).

(permutite, saturated with 30% Ca + 70% K)

Variants of samplings	Dry weight of plants in g per vessel	Contents of potassium in plants		Increase of potassium compared to control	
		in % of air-dried substance	in mg per vessel	in mg	in relative amounts
Before the experiment (control)	4.20	0.281	11.82	—	—
Permutite: in contact	4.29	0.827	35.47	23.65	100
in isolation	4.51	0.568	25.60	13.78	58

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It is apparent from studying the table, that the corn shoots avidly absorb potassium from the outer medium even during a short experiment: during 48 hrs the content of potassium in plants, at a contact of roots with permutite, tripled compared to the control (with the content of potassium before the experiment).

Role of contact exchange was shown here more clearly, than in experiments with a lengthy reaction. Yet the plants were able, also under conditions of a short duration experiment, to mobilise, with the aid of their root secretions, more than half of the total amount of the absorbed potassium.

The cited experiments with absorption of potassium were conducted with permutite, which was highly saturated with this cation (potassium displaced 70% of the whole capacity of exchange of the adsorbent). We already pointed out previously, when interpreting the mechanism of the contact exchange, that a selective absorption by the roots of these or others cations from water films, surrounding the colloidal particles, must have a more marked advantage before their absorption from intermicellar liquid in that case, when the given cation has a weak mobility, which hampers the maintenance of a favorable concentration to the plant of this cation in intermicellar liquid.

Issuing from this circumstance, it was very interesting, as from a theoretical, so also from a practical point of view, to investigate experimentally (Begin p. 186) the role of contact exchange during absorption by the plants of these or other exchangeable cations, depending on the rate of their mobility on the adsorbent.

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The rate of saturation of the adsorbent with this cation is the most essential factor, which determines the mobility and the availability to plants of one or another exchangeable cation. Therefore we tried, first of all, to investigate the importance of this factor for clarifying the role of contact exchange during absorption of exchangeable potassium by the plants.

For this purpose the same initial permutite, which served us for the previous experiments, underwent a treatment according to the above cited method, with only one difference, that after saturation of permutite with calcium it was treated with a weaker solution of potassium chlorides; with a smaller amount of solution in relation to the weight of the adsorbent, than in the foregoing experiment. As a result of this a sample of permutite was obtained which was saturated with potassium only to 30% of the whole exchange capacity, and the remaining 70% with calcium (the foregoing experiments were conducted, as was pointed out, with permutite, containing potassium and calcium exactly in reverse proportions: 70% K and 30% Ca).

The experiment was conducted with the same kind of corn and the procedure was the same as was described before for experiments with a reaction of long duration. Dose of permutite taken was calculated to be 100 mg of potassium per vessel. This made up about a quarter of Prianishnikov's norm (the vessels taken were of a somewhat smaller capacity than in the foregoing experiment).

The plants were transplanted when six days old and were harvested 34 days after planting.

Results of the experiment are shown in table 69.

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Permutite - 40.0% of exchange capacity was replaced by potassium and 59.1% by calcium;

Bentonite - 50.4% of exchange capacity was replaced by potassium and the remaining 49.6% by calcium.

Preliminary laboratory experiments on studies of mobility of exchangeable potassium on these adsorbents in a reaction with carbon dioxide, which were conducted similarly to those previously cited, showed a greater mobility of potassium on bentonite compared to permutite. Thus, concentration of potassium in the dialysate after a reaction of a weak flow of CO_2 in the course of 4 days, with a double decantation of the dialysate comprised in the case of permutite 2.62 mg, while in the case of bentonite 4.85 mg of potassium per liter.

Adsorbents, prepared in the above described manner, were taken for vegetative experiments at a rate of 150 mg of potassium per vessel.

Procedure of the experiment was similar to that cited previously. Corn of "Sterling" variety was transplanted into the vessels on the sixth day of its growth and was harvested in 54 days. Replication was fourfold. Results of the experiment are given in table 70.

Data of table 70 show, that in the case of bentonite the presence of contact between the plant roots and the adsorbent did not produce any influence on the weight of the plant and a very weak influence on the amount of potassium absorbed by them, whereas in the case of permutite this influence was conspicuously expressed.

Let us further point out a curious fact, about which we shall talk later in greater detail, that differences in the mobility of potassium on adsorbents, in question, which were discovered in the laboratory experiment with the reaction of CO_2, were reflected in the availability of this potassium to the plants only under conditions of iso-

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Table 69.

Role of contact between roots and the adsorbent during absorption by plants of exchangeable potassium.
(permutite, saturated with 30% K + 70% Ca).

Variants of the experiment	Dry weight of plants in g per vessel	Increase of weight compared to the control		Content of potassium in plants in mg per vessel	Increase of potassium compared to the control	
		in g	in relative amounts		in mg	in relative amounts
Without potassium (control)	7.64	-	-	22.72	-	-
Permutite						
in contact	29.69	21.85	100	57.28	34.56	100
in isolation	23.50	15.46	71	46.20	23.48	68

[Begin p. 187]

Analysis of data in table 69 shows that when the rate of saturation of adsorbent with potassium is lowered the role of contact exchange appeared more clearly than in the foregoing experiment (table 67), at a much higher saturation of the adsorbent with potassium.

The next experiment was directed to investigate the importance of another factor, which determines the mobility of exchangeable cations on an adsorbent, namely, on the importance of the nature of the adsorbent itself.

For this purpose, besides permutite, another adsorbent was taken into the experiment - bentonite, as a representative of colloidal clays which are more widely spread in soils and belong to the montmorillonite group. The capacity of cation exchange of bentonite appeared to be equal to 66.4 m - eqv per 100 g of substance.

Permutite and bentonite were subjected to preliminary treatment according to the above cited method as a result of which samples with the following composition of exchangeable cations were obtained:

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lation of this adsorbent from the roots. But in the presence of contact between the roots and the adsorbent the availability [Begin p.186] of potassium to the plants shows rather a reverse relation to its mobility, which was estimated by a chemical method (the plants absorbed more potassium from permutite, than from bentonite).

Table 70.

Role of contact between roots and the adsorbent during absorption of exchangeable potassium by plants depending on the nature of the adsorbent.

Variants of the experiment	Dry weight of plants in g per vessel	Increase in weight compared to the control		Contents of potassium in plants in mg per vessel	Increase of potassium compared to control	
		in mg	in relative amounts		in mg	in relative amounts
Without potassium (control)	3.54	-	-	7.21	-	-
Permutite:						
in contact	20.58	17.04	100	82.91	75.70	100
in isolation	15.70	12.16	71	57.78	50.57	67
Bentonite:						
in contact	19.01	15.47	100	70.62	63.61	100
in isolation	19.80	16.26	105	62.67	55.66	88

Summing up the cited experiments on potassium absorption one can say, that they established a dependence of the relative role of contact exchange, in the general mechanism of absorption by plants of exchangeable potassium, on the length of reaction between the roots and the adsorbent, on the rate of saturation of this last one with potassium, as well as on the nature of the adsorbent also on a rate of mobility of potassium absorbed on it.

Later on it was important to trace the growth of the role of contact exchange in the presence of a combination of the above cited factors. For this purpose an experiment with the same samples of

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permutite and bentonite was repeated under conditions of a short duration reaction (48 hrs), including also permutite, which was saturated to 70% K and 30% Ca.

The procedure of the experiment with a short duration reaction was cited previously. The adsorbents were taken at a rate of 80 mg of potassium per vessel of about 1 liter capacity. Into each vessel were transplanted 14 plants, identical in vigor of development, which were carefully selected (the same corn, variety Sterling). Preliminarily the plants were grown on culture medium, Helreigels solution, in a concentration of 0.1 of the norm and were taken for the experiment after 10 days of growth. Replication was threefold. The length of reaction was 48 hrs.

Results of the experiment are given in table 71. In the last column are given results of laboratory experiments on studies of mobility [Begin p.189] of potassium on adsorbents in question with a CO_2 reaction on them.

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Table 71.

Role of contact between the roots and the adsorbent with an absorption by roots of exchangeable potassium depending on the nature of the adsorbent and the rate of saturation of it with potassium (an experiment of short duration).

Variants of samplings	Dry weight of plants in g per vessel	Contents of potassium in plants in mg per vessel	Increase of potassium compared to control		Concentration of potassium in the dialysate in laboratory experiments with a reaction of CO_2 in mg per liter
			in mg	in relative amounts	
Before the experiment (control)	3.63	17.20	-	-	-
Permutite, saturated to 70% K + 30% Ca in contact	3.76	46.91	28.71	100	4.10
Same, in isolation	3.74	34.74	17.14	60	
Permutite, saturated to 40.9% K + 59.1% Ca in contact	3.76	46.65	29.45	100	-
Same, in isolation	3.93	31.93	14.73	50	2.62
Bentonite, saturated 50.4% K + 49.6% Ca in contact	3.67	41.19	23.99	100	4.85
Same, in isolation	3.80	37.47	20.27	85	

We should note first of all in the cited data that differences in the mobility of potassium, estimated by a chemical method, here too were reflected only in a case of isolation of adsorbents from the roots. As we see, during an isolation of adsorbents availability of their potassium to the plants grew thus: permutite, saturated to 40.9% of potassium, < permutite, saturated to 70% potassium, < bentonite, saturated to 50.4% of potassium, that is corresponding to the rise of mobility of potassium on these adsorbents under conditions of the laboratory experiment. If one takes into consideration that, during isolation of adsorbents, mobilization of potassium, absorbed on them, proceeds under the reaction of root secretions, among which, as we saw, a reaction of carbon dioxide alone is of specific importance, then the result obtained

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becomes understandable, because under conditions of isolation we really estimate the mobility of potassium by a chemical method with only one difference that the reagent (carbon dioxide) is not brought in from outside, but is produced right here as a result of metabolic activity of the root.

Yet does it correspond to the availability of potassium to the plants during direct reaction of roots with the adsorbent? [Begin p.190] It turns out that no such correspondence exists either in this experiment, or in the foregoing one (with a long duration reaction). Under conditions of contact between the roots and the adsorbent, besides the chemical mobility of potassium on the adsorbent there is an influence of some other factors which are linked with contact absorption, the nature of which is not yet clearly known to us, and which, as we already saw, can overlap the importance of chemical mobility.

Thus, in the cited experiments we again came to that conclusion to which we were led by our earlier researches about the availability to the plants of exchangeable calcium, depending on the composition of accompanying exchangeable cations (Rather, 1938). In these researches, with a lowering of the saturation of the soil with calcium at the expense of its replacement with hydrogen we discovered a quite opposite effect in the influence of this factor on the availability of calcium to the plants on the one hand, and on its mobility, at a reaction with a solution of a neutral salt, - on the other. Hence we had to make a conclusion, that in many cases "desorption from the soil of exchangeable calcium by a cation of a neutral salt does not give any idea (or, rather, gives a wrong idea) about conditions of physiological desorption of this

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calcium by plant roots"3 (Ratner, 1938, p.1174).

Lately this point of view found a confirmation in an application to the question about the availability to the plants of exchangeable potassium in a work of M. Elgabaly, H. Jenny and R. Overstreet (1938). These authors, studying the availability to plants of potassium and zinc, which were absorbed on bentonite and on kaolinite have discovered a much higher availability of the named cations to plants from a bentonite suspension than from a kaolinite suspension. Meanwhile, the laboratory experiments, with desorption of these cations with the aid of carbon dioxide or a weak solution of hydrochloric acid, have shown quite an opposite relationship - their desorption from kaolinite proceeded noticeably easier, than from bentonite.

Thus, physiological desorption of cations, a contact absorption being one of its many elements, appears to be a process much more complicated than just a chemical desorption, which is conducted in a laboratory, or by the plant itself during isolation of its roots from the adsorbent.

Returning to the basic aim of our experiment - clarification of the role of contact exchange depending on the rate of mobility of potassium on an adsorbent, it is necessary to note that in the experiment this dependence became apparent sufficiently clear. In the case of bentonite, which is characterized by a high mobility of potassium absorbed by it, the role of contact exchange also under conditions of a short duration experiment was just as insignificant, as it was in the long [Begin p.191] reaction. In the case of permutite, which was saturated to 40.9% of its exchange capacity with potassium half of the total amount of potassium absorbed by plants falls to the lot of contact exchange.

For a further confirmation of the same idea about the decisive importance of the rate of mobility of the exchangeable cation on the adsorbent

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for the manifestation of the role of contact exchange during its absorption by the plants, it is interesting to find out the influence in this respect of yet a third factor, which determines the mobility of cations on the adsorbent, namely - composition of accompanying exchange cations.

As we already saw from foregoing chapters, the sodium ion occupies a special place among exchangeable cations of the soil in its influence on the mobility and availability to plants of accompanying cations. The most sharply expressed influence of sodium is in relation to the availability to the plants of exchangeable calcium, but even in relation to availability to them of exchangeable potassium it is expressed sufficiently observable, especially under conditions of the short duration experiment, where phenomena, which are complicating the picture, are excluded, those which are linked to plant's utilization also of non-exchangeable forms of potassium in the soil.

Taking into account this circumstance, we set ourselves as an object to trace, in our experiments with a short duration reaction, the changes in the role of contact exchange during absorption by plants of exchangeable potassium, the lowering of mobility of which on the adsorbent was reached by mixing it with exchangeable sodium, as an accompanying ion. For a comparison such variants were taken where potassium was combined with calcium as an accompanying ion, as well as such in which potassium saturated the full exchange capacity of the adsorbent. Thus, in this experiment were combined influences of two factors on the change of potassium mobility: 1) lowering of the rate of saturation of the adsorbent with potassium, and 2) substitution of calcium, as an accompanying cation, by sodium.

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Red soil from Chakvinskaia Experiment Station was taken for the experiment; all the exchangeable cations were removed by treatment on a filter with 0.05 N HCl with the following washing with water up to the disappearance of chlorides.

The soil, thus obtained, was then saturated with K, Na and Ca by way of treating it by diluted solutions of KOH, NaOH and $Ca(OH)_2$. The cited reagents were introduced at such a rate as to obtain in one case a soil fully saturated with potassium, in another - 60% potassium and the remaining 60% calcium, and finally in the third case - saturated to 50% with potassium and the remaining 50% with sodium. Reaction of the soil with the cited reagents continued for 6 days with frequent [Begin p.192] stirrings. Preliminary experiments for obtaining titration curves have shown that with titration of a solution of 0.05N KOH the exchange capacity of the soil at pH 7.0 constitutes 20 m - eqv per 100 g of soil, which was taken into consideration when saturating the soil with the cited cations.

Procedure for the experiment was the same as described earlier, with the only difference, that collodion bags were substituted by parchment ones because it happened that the highly dispersed soil, saturated with alkaline cations (100% K or 50% K + 50% Na) partly seeped through the colloid.

Barley, Viner 1163, was taken for the experiment, which before that was grown in water from the water system with an addition of Helreigel's solution at a half dose in all elements except potassium, which was introduced in a dose corresponding to one fourth of Helreigel's norm. The plants were taken into the experiment after 15 days of growth. 30 plants, identical in their vigor of development and carefully chosen, were transplanted into each vessel.

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The weighed portions of soil for the preparation of suspensions were taken in all cases at a rate of 100 mg of exchangeable potassium per vessel of about 1 liter capacity. Duration of the experiment - 48 hrs. Liquid in the vessels was aerated every hour for 10 min (with a break for the night). Replication - threefold.

The plant roots were carefully washed in distilled water after harvesting. The experimental plants were then dried, weighed and underwent analysis for the content of potassium, as well as were the other plants, which were taken before the experiment (control).

Results of the experiment are shown in table 72.

From an analysis of this table it appears that the role of contact exchange grew sharply with the lowering of potassium's mobility on the adsorbent. In a case of the soil, which was fully saturated with potassium, all plants have absorbed practically similar amounts of potassium, regardless of the fact if the roots were in contact with the soil particles or were isolated from them by a parchment membrane. At the lowering of the rate of saturation of the soil with potassium to 60%, by way of displacing the rest of the exchange capacity of the soil with sodium, isolation of the suspension from the roots decreased by twice the amount of potassium absorbed by the plants.

Results of two last experiments can be seen especially clear from their graphic representation. In figure 18 on the axis of abscissa are plotted amounts of potassium which were absorbed by the plants at an isolation of the adsorbents from roots. They reflect the differences in the rate of mobility of potassium on adsorbents, taken for this experiment.

On the axis of ordinate are plotted the amounts of potassium absorbed additionally by the plants as a result of contact, expressed in %

(sentence continues on page 193, after table 72) [Begin p. 193]

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Table 72.

Role of contact between the roots and the adsorbent during absorption by plants of exchangeable potassium, depending on the rate of saturation of the adsorbent with potassium, and the nature of accompanying exchangeable cations.

Variants of samplings	Dry weight of plants in g per vessel	Contents of potassium in plants in mg per vessel	Increase of potassium compared to control	
			in mg	in relative amounts
Before the experiment (control)	1.47	22.87	-	-
Soil, saturated with potassium to 100%:				
in contact	1.80	38.80	16.63	100
in isolation	1.78	39.91	17.04	103
Soil, saturated to 50%K and 50%Na:				
in contact	1.72	33.68	10.71	100
in isolation	1.70	28.61	5.74	53
Soil, saturated to 50% K and 50% Ca:				
in contact	1.76	37.32	14.45	100
in isolation	1.72	34.48	11.61	80

from the whole amount of potassium absorbed by plants in the given variant of the experiment. The difference, which was obtained by way of deducting from the amount of potassium absorbed in the presence of contact between the roots and the adsorbent the amount which was absorbed in the absence of this contact, is referred to the share of the contact absorption.

From the graphic, as well as the numbrical data cited up to now it is clearly seen, that independently of the method of decreasing the mobility of exchangeable potassium on the adsorbent (by changing the rate of its saturation with potassium, by changing the composition of accompanying exchangeable cations or by varintions in the nature of the adsorbent itself), independently of the choice of the experimental plant (corn in one experiment, barley - in another), of the nature of the membrane, which separates the roots and the adsorbent (collodion in one experiment, parchment in another), as well as of the procedure for conducting the experiment (the long and the short duration of the reaction)

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we meet in all cases with one and the same regularity - increase of the role of contact exchange in the general mechanism of plant absorption of exchangeable potassium in proportion to the lowering of the rate of mobility of potassium on the adsorbent.

If on the graph, in figure 15, one should mentally continue the curves to the left side, that is to the side of still greater [Begin p.194] decrease in mobility of exchangeable potassium on the adsorbent, we must meet conditions of decisive import of contact exchange for the absorption by plants of exchangeable potassium.

Mobility of potassium on adsorbents (absorption of potassium by plants in mg during isolation of the adsorbent from the roots).

Figure 15. Role of contact during absorption by plants of exchangeable potassium according to the rate of its mobility on an adsorbent. 1-Permutite, saturated to 40.9%K + 59.1% Ca; 2-the same, to 70%K + 30% Ca; bentonite, saturated to 50.4%K + 49.6% Ca; 4-soil, saturated to 50%K + 50% Na; 5-same, to 50%K + 50% Ca; 6-same, to 100%K.

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Further, it is necessary to take into consideration that in natural soils their saturation with potassium usually is expressed only in a few percent, and often even in parts of a percent of the exchange capacity, that is in amounts of quite different order, than in our experiments, and that at such a rate of saturation the mobility of potassium is very negligible. That is why one can assume, that in natural soils in combinations of exchangeable potassium with calcium and magnesium, and the more so with sodium, its absorption by plants occurs to a large degree by means of contact exchange.

The rate of saturation of the soil with calcium is usually incomparably higher. Yet at the same time calcium has a lower mobility than potassium. Combination of these two contrary acting circumstances determines then the role of contact exchange during plant absorption of exchangeable calcium.

In conclusion we want to stop on one objection, which could be made in relation to our experiments with reaction of short duration.

Increase of the role of contact in these experiments could be [Begin p.195] explained by a retarding influence of the membrane itself on diffusion of cations which have become separated from the adsorbent into the outer liquid in which the roots were. A fact that under conditions of high saturation of the adsorbent with calcium or potassium (or in general with their high mobility on the adsorbent) the role of contact does not show, could be ascribed to a circumstance, that with a high mobility of a given cation the difference in its concentration inside the bag and outside of it does not play any importance for its absorption by the roots, whereas with a low mobility of a cation this factor (difference of concentration, as a result of slowing of dif-

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fusion) does produce its influence.

The idicated objection is especially applicable in relation to parchment bags, because the laboratory experiments show that parchment membrane actually offers a resistance to diffusion. Strictly speaking, this circumstance was one of the causes of replacement in laboratory practice of parchment with colloid and other membranes which produce a lower resistance to diffusion (Naumov, 1932).

Yet in our experiments we had two favorable circumstances, which were decisive in the determination of intensiveness of the diffusion process.

First and chief among them was that the plant roots practically fully exhausted the outer solution in relation to potassium which entered it from the bag, and, consequently, during the course of the whole experiment in the system the maximum possible gradient of concentration of potassium in the liquid inside the bag and outside was upheld. And this is the first condition, defining the intensiveness of the process of diffusion.

The second circumstance consists of the fact that the surface of the bags, especially of parchment ones with many folds, was very considerable for their small volume, which also helped the free and fast movement of potassium from the bag into the outer solution in proportion to exhaustion of potassium from the latter one by plant roots. Finally, as it was indicated, the liquid in the bag and outside it was repeatedly stirred.

Every thing taken together allowed to assume that the inhibiting action of the membrane on diffusion of cations, separated from the adsorbent, should not be a substantial factor, which was able to distort the role of contact exchange.

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Yet this assertion demanded a verification by an experiment. This checking-up was conducted in the following manner.

The plants of barley, Viner 1163 variety, were grown on the water system water with an addition of a nutritive solution of Helreigel (quarter [Begin p.196] of potassium norm and half of the norm of all the rest of elements). After 12 days of growth the plants were placed by their roots into the solution of potassium chloride, which was introduced, in one case, directly into the vessel with the roots, and in another case - isolated from them in the same parchment bags (of similar size), which were used in previous experiments.

The amount of potassium chloride was taken at a rate of only 20 mg of potassium per vessel. This was 6-8 times less than in the above cited experiments with adsorbents. Into each vessel 35 plants were transplanted. In the rest the procedure of the experiment was the same, as in experiments with adsorbents.

After 48 hrs the plants were removed, dried, weighed and underwent analysis for the content of potassium in them.

In table 73 are given results of this experiment.

Table 73.

Influence of a collodion [sic] membrane on the absorption of potassium by plants from a potassium chloride solution.

Variants of the experiment	Dry weight in g per vessel			Content of potassium in plants in mg per vessel	Potassium absorbed from solution	
	of roots	in above ground organs	Total		in mg	in %
Before the experiment (control)	0.69	0.83	1.42	15.59	-	-
KCl:						
in contact	0.69	1.09	1.68	32.23	16.64	100
in isolation	0.69	1.03	1.62	31.90	16.31	98

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Data, given in table 73, show that during 48 hrs of the experiment the plants, from a small dose of potassium (which corresponds to conditions of low mobility of potassium in the soil), absorbed more than 80% of its introduced amount, whereupon the presence of parchment membrane did not inhibit the intensiveness of absorption of this potassium by the roots.

Thus, the increase of the role of contact exchange, found out by us, in proportion to the decrease of the rate of mobility of cations on the adsorbent cannot be ascribed to the peculiarities of the procedure, especially as the results of the experiment with short duration reactions are in full agreement with the results of experiments with a long duration reactions. The essence of this phenomenon lies in principally different possibilities of plant feeding from a highly saturated complex, which is readily yielding the exchangeable cations into the solution at the reaction of root secretions (CO_2), and from a weakly saturated complex, which retains the cations more stably and releases them to the plant in [Begin p.197] a considerable degree without transfer into the intermicellar liquid (their absorption by the roots from "micellar solution" in the presence of direct contact between the absorbing surface of the root and the adsorbent).

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4. Role of contact exchange during plant absorption by plants of sorptionally fixed phosphoric acid.

Studies of the role of contact exchange in the general mechanism of absorption by plants of adsorptively held anions, in particular of phosphate-ions, are fraught with greater difficulties, than studies of this problem in application to exchangeable cations of the soil.

We already pointed out in chapter 1, that the phenomenon itself of adsorptive absorption of phosphate-ions in the soil is only of late finding proofs of reality of its existence. However, much here still remains unclear, chiefly because of the sharply expressed chemical affinity of phosphate-ions to sesquioxides of the soil - the main component of the absorbing complex of the soil, which takes part in absorption of anions. Many indicators, which are easily taken into account and are concretely expressed for exchangeable cations: capacity of cation exchange, degree of saturation, composition of accompanying exchangeable cations, and so on, are devoid of this concreteness, when applied to anions, the more so because the phenomenon of reversibility of adsorptive absorption, which principally lies at the basis of obtaining the cited indicators, is far from having been studied in relation to anions.

One should add to this, that the problem about the role of exchange adsorption in absorption of phosphate-ions by a plant from the outside medium is also not as clear as the problem, about the role of exchange adsopption in plant absorption of cations.

Nevertheless, one should admit that the principal possibility of adsorptive, or, speaking in a more general form, of sorptional fixation of anions, including phosphate-ions, either by soils or

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by plant roots, has been already proved at the present time, a fact, about which we already spoke in Chapter I. Therefore it was interesting to investigate the possibility of a contact exchange between roots and adsorbents not only in an application to cations, but also to anions, and, in particular, to phosphate-ions, for sorptional fixation of which in the soil there are more favorable conditions when compared to other anions.

In chapter II were given experiments which tried to throw light on the possibility of contact displacement from the plants of phosphate-ions by the gel of iron or the suspension of red soil, which are distinguished by a sharply expressed ability to absorb [Begin p.198] phosphoric acid. It was not possible in these experiments to find a clearly expressed desorption of phosphate-ions from the roots.

Later on it was interesting to examine the role of contact exchange in reverse connections, that is during desorption by plants of phosphate-ions from an adsorbent.

Experiments with phosphoric acid were conducted for this purpose; the acid was sorbed on the gel of ferric hydroxide which was prepared according to a procedure used in the laboratory of A.F. Tiulin and described in detail in an article by V.I. Shtatnov and A.S. Odintsova (1935).

The moist gel of iron was flooded with 0.1 molal solution NaH_2PO_4 in ratio of the amount of solution (in cc) to the weight of absolutely-dry gel (in g) 200:1.

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After a 48 hour standing, with frequent and energetic stirrings, the liquid was filtered on a Büchner's funnel with suction, and the sediment was washed in water for a long time until only slight traces of phosphoric acid were found in the filtrate.

The sediment, which was removed from the filter, was slightly dried in the air in order to remove excess water, after which it was carefully stirred and later on kept in a desiccator, in an atmosphere saturated with water vapors. Analysis showed in it content of 24.4% of absolutely-dry substance and 13.03% P_2O_5 in ratio to absolutely-dry, or 3.18% P_2O_5 to the moist substance.

One should state that we have no basis to regard all the phosphoric acid, determined by the analysis in the prepared gel of iron, as adsopptively fixed, because a certain part of it, probably, was chemically fixed, which was pointed out also by A.F. Tiulin (1936) in regard to preparations which were made in his laboratory.

Moreover, the form of bond of phosphoric acid in similar kinds of preparations must also have a change in time. If one reckons, that the initial stage of absorption is completely attributed to adsorptive fixation of phosphate-ions by the positively charged gel then, subsequently, formation of chemical bonds begins to play a role, and with still longer processes - crystallization of phosphate with sesquioxides in a form of individualized vadose, phosphorus-containing minerals (Polynov, 1934).

To our regret, we do not yet have any reliable methods, which would allow us to separtely calculate the adsorptively held and chemically fixed phosphoric acid in preparations, similar to those obtained by us.

An experiment with corn of "Belaia Angliiskaia" variety, according

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to a procedure described earlier, was conducted with the gel of iron, obtained in this way and saturated with phosphoric acid. [Begin p.199]

The nutrient solution of Prianishnikov, without phosphorus, was introduced into the outer vessel (with sand). Nitrogen was added in order to avoid sharp shifts in the reaction of the medium in the absence of a phosphate buffer; half in a form of NH_4NO_3, and half in a form of $Ca(NO_3)_2$. Microelements (boron and manganese) were added.

The gel of iron, containing phosphoric acid, was introduced into the inner vessel; minute amounts of calcium and of microelements were also added for a better development of roots.

Also for checking an objection, in respect to phosphate-ions also, that the presence of a collodion membrane could, in itself, become a factor which retards the utilization by plants of phosphoric acid, which separated itself from the absorbent, and also for calculations of comparative availability of P_2O_5 to the plants from the gel of iron compared to another more available phosphate were also introduced into the experiment for control variants with slightly soluble calcium phosphate ($CaHPO_4 \cdot 2H_2O$), which is easily soluble under the influence of root secretions (carbon dioxide), and easily abailable to the plants. This phosphate was given to the plants under the same conditions as the gel of iron; that is, in one case in contact with the roots, and in another - isolated from them with the aid of collodion membrane. Later, on, for a better exposure of the role of contact exchange as an additional mechanism during absorption by plants of phosphoric acid the latter one was introduced in a dose, reduced by two times, compared to Prianishnikov's norm (or of Helrigel).

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Corn shoots were preliminarily grown in water from the water system, and after 7 days of growth were transplanted into the vessels. The plants grew in vessels for 45 days, developing normally in all variants with P_2O_5, but lagging noticeably on the gel of iron when compared to semi-liquefiable phosphate, which is seen from figure 14.

Replication of the experiment was fourfold, harvesting was done on 25.VIII, 1940. The harvested plants were dried, weighed and analyzed for the content of phosphorus, according to Lorents. Results of the experiment - the weight of plants and content of phosphoric acid in them is given in table 74. The general view of plants is shown in figure 14.

From examination of the table it is first of all seen, that the presence of collodion membrane was not an obstacle to the use by plants of phosphoric acid which migrated into the solution under the influence of root secretions which penetrated through the walls of the bag, as also under the influence of hydrolysis. That one fact speaks about this matter, that in the case of calcium phosphate the weight of plants, in a variant with isolation, as also the contents of P_2O_5 in these plants, do not lag behind the corresponding data for the variant "in contact". [Begin p.200]

Then, from results of the table it follows, that harvest from phosphoric acid adsorbed on gel of iron, as well as the content of P_2O_5 in this crop, yield to corresponding data for slightly soluble phosphate by 2-3 times. If one calculates that according to data of D.L. Askinasi and D.M. Kheifets (1938), (the sentence continues after figure 14.)

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Title of figure 14. - Role of contact during absorption by plants of phosphoric acid (water - sand cultures of corn with double isolation of roots. 1 - without phosphorus; 2 - $CaHPO_4$ in contact with roots; 3 - $CaHPO_4$ in isolation from roots; 4 - gel of iron from absorbed phosphoric acid in contact with roots; 5 - the same, in isolation from roots.

the plants absorb phosphoric acid from iron phosphate, which is highly saturated with phosphoric acid, almost at the same rate as from the soluble phosphate, then one must admit that in our preparation phosphoric acid had very weak mobility and was very difficultly available to the plants. And yet, notwithstanding the weak mobility and a low coefficient of utilization by plants of phosphoric acid which was introduced with the gel of iron, contact between the roots and the adsorbent produced a very slight influence on the weight of plants and on the amount of phosphoric acid absorbed by them. [Begin p.201]

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Table 74.

Role of contact during absorption by the plants of phosphoric acid, adsorbed on the gel of ferric hydroxide

Variants of the experiment	Dry weight of plants in g per vessel	Increase in weight compared to control		Content of phosphorus in mg per vessel	Increase of phosphorus compared to control		pH of the liquid in inner vessels after harvesting
		in g per vessel	in relative amounts		P_2O_5 in mg per vessel	in relative amounts	
Without P_2O_5 (control)	4.9	-	-	15.2	-	-	6.9
$CaHPO_4 \neq 2H_2O$:							
in contact	36.6	31.6	100	201.1	187.9	100	6.1
in isolation	39.0	34.1	108	199.7	186.6	99	-
Gel of iron:							
in contact	21.6	16.6	100	67.1	53.9	100	6.0
in isolation	19.0	14.1	85	58.3	45.1	84	-

Thus we did not succeed in this experiment also to detect the role of contact exchange in respect to phosphate-ions. Separation of ions from the adsorbent and their conversion into a solution under the influence of processes of hydrolysis or under reaction of root secretions had a decisive meaning for the absorption of these ions from the adsorbent.

The question is, what kind of root secretions are these and what is their relative importance for mobilization of phosphoric acid from the gel of iron, compared to the processes of hydrolysis, which proceed independently of the active reactions of plants?

In order to answer these questions laboratory experiments were conducted which were similar to the described above in respect to potassium.

A water suspension of the gel of iron was suspended in similar collodion bags and in similar vessels that were used in vegetative tests. Those weighed portions of gel, together with the bags, which

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were used in inner vessels for the experiment with corn, and have already given up part of their phosphoric acid to the plants, were taken along with new weighed portions of gel. Further on, for comparision under similar conditions, weighed portions of disubstituted calcium phosphate were taken into the experiment. All phosphates were taken in amounts of 200 mg P_2O_5.

The contents of the bags, as well as the outside liquid in vessels was stirred 6-7 times per day.

After two twenty-four-hour periods the outside liquid was siphoned off and (after condensation by evaporation, if that was necessary) contents in it of phosphoric acid were determined colorimetrically, according to Nemets. [Begin p.202]

Analysis showed that the gel of iron, which was in the experiment with plants, released to dialysate only scarcely noticeable traces of phosphoric acid. Dialysis from the new gel of iron contained 0.15 mg PO_4 per L. and dialysis from disubstituted calcium phosphate - 15 mg of PO_4 per L. After this the liquid in vessels with the gel of iron was changed 5 more times, 2 days apart. Analysis showed that with such a multiple dialysis, with two-day intervals, gel of iron guaranteed in dialysis an upkeep of concentration of phosphoric acid of 0.1 mg PO_4 per L, while the used gel showed only insignificant traces of PO_4.

Even if one allows that under conditions of a vegetative experiment the speed of reinstatement of indicated concentration of PO_4 in the outside liquid with the aid of processes of hydrolysis was guaranteed during the whole period of plant growth and kept up with the speed of extraction of these ions by the roots, even in this case one should recognize, that processes of hydrolysis could not play

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a decisive role in determination of availability to plants of phosphoric acid, which was held by the gel of iron. We already pointed out in our literature to the experiments of L. Teakle (1929) and F. Parker (1928) which showed that concentration of phosphoric acid about 0.1 mg PO_4 per L is already critical for plants, and that in experiments of Teakle, at this concentration, the plants showed strong signs of suffering and a stumped growth, which did not happen in our experiment.

Besides this, analysis of the dialyzate from the gel of iron, which was previously in a test, shows that a tolerance about the fact that this concentration could be guaranteed by the processes of hydrolysis during the course of the whole period of the plants' growth does not have any basis: in case of the gel of iron, which was already used in an experiment, the dialyzate contained only traces of phosphoric acid.

After determining the insignificant role of processes of hydrolysis in the mobilization of phosphoric acid of the phosphates which interest us, the laboratory experiments were continued in a direction of study of a possible role in this respect of carbon dioxide, secreted by roots. For this purpose a slow flow of carbon dioxide was passed for a period of two days to 6 or 7 times a day for 10 minutes through the outer liquid in the vessels, after which the liquid was poured off and the content of phosphoric acid was determined in it.

Analysis showed that as a result of reaction of carbon dioxide the content of phosphoric acid in the dialyzate was expressed by slightly noticeable traces not only in the case of gel of iron, which was previously used in an experiment but also in the case of the new gel, which,

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as previously indicated, guaranteed a concentration of about 0.1 mg of PO_4 per liter. Meanwhile the content of phosphoric acid the dialyzate from disubstituted calcium phosphate [Being p.203] increased under the influence of carbon dioxide from 16 to 76 mg of PO_4 per liter.

These data show very convincingly that if one excludes the possibility of other root secretions, besides carbon dioxide, then the plants, under conditions having place in our experiment (isolation of the phosphate from the rest of nutrient solution in bufferless medium, with a plentiful secretion of carbon dioxide by the roots), would become quite incapable to achieve any noticeable utilization of phosphoric acid from the gel of iron. And from here issues an inevitable conclusion about the decisive role, in this respect, about other root secretions, besides carbon dioxide.

Unfortunately, we, to the present time, have not yet enough reliable and detailed data about the composition of root secretions of different plants. Yet, undoubtedly, in these secretions some organic acids are found, malic acid in particular; its presence in root secretions was spoken of by several authors (Maze, 1911; Shulov, 1915; Minina, 1927, and others). The presence in them of sugars, is beyond doubt, and probably, under certain conditions, also of nitrogen-containing organic substances (Lyon and Wilson, 1921; Krasilnikov, 1934; Isakov, 1944; Tepper, 1949, and others).

In order to have an idea about a possible role of some organic substances, in the first place of malic acid, in the mobilization of phosphoric acid from the gel of iron, further experiments were conducted in such a way that the outer liquid in the vessel was substituted not by water, but by 0.0016 molal solutions of malic and

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citric acids or solutions of citrate of ammonium, in the same concentration.

For this purpose, the gel of iron taken was that which already was previously used in an experiment, and as it was pointed out, which gave out into the dialysis only slightly noticeable traces of phosphoric acid.

After a two-day reaction of the reagents in question with this gel of iron the dialyzate contained, according to data of analysis, the following amounts of phosphoric acid:

in the case of malic acid 0.4-0.5 mg PO_4 per liter

" " citric acid 0.6-0.7 mg PO_4 " "

" " citrate of ammonia 25 mg PO_4 per liter

A stable concentration of phosphoric acid, corresponding even to the smallest of the cited figures, could have guaranteed a normal growth for plants, as it is seen from works of Teakle and Parker. In particular, in experiments by Parker, concentration of 0.4 mg PO_4 per L was the most favorable for corn.

The cited vegetative and laboratory experiments allow one to come to conclusion, that a mechanism of absorption by plants [Begin p.204] of phosphoric acid, held by the gel of iron, includes an active reaction of a living plant with an adsorbent. This reaction is based only to a slight degree on the phenomena of contact exchange. It is still less connected with the influence of carbon dioxide. At the base of this mechanism lies chiefly the reaction on the adsorbent of organic root secretions, and, in the first place, of organic acids.

Let us note, that this conclusion refers to that certain rate of saturation of the gel of iron with phosphoric acid, which had place in

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saturation of the adsorbent by phosphoric acid the phenomenon of hydrolysis can occupy a more prominent place in this mechanism.

Let us note further, that a comparison of results of cited laboratory experiments with the gel of iron with results of similar experiments with permutite and bentonite, containing the exchangeable potassium, shows the inconsistency of a dispute about which of the root secretions determine the active reaction of plants with the solid phase of the soil, be it carbon dioxide, as it is maintained by Truog, Fageler, and others, or organic root secretions, but not carbon dioxide, as asserted by Comber, Parker and others. From the examined experiments wersaw, that already in respect to mobilization of exchangeable potassium already a reaction of only carbon dioxide alone can have a decisive meaning (with a high saturation of the adsorbent with potassium); it follows then that in respect to phosphoric acid, which is adsorbed on the gel of iron, the organic root secretions have a decisive meaning, whereas the influence of carbon dioxide can be even negative.

In any way, there is no reason to recognize in our experiment the contact exchange as having a considerable, or even a decisive role in the general mechanism of absorption by the plants of sorptionally held phosphoric acid. This role was played here by the ability of plants to release the phosphoric acid, held by the gel of iron, by means of root secretions.

Inasmuch as this ais a fact and inasmuch as individual agricultural crops differ substantially from one another in quality and quantity of root secretions and in the general vigor of development of root systems, one could expect that peculiarities of these plants will find a reflection in their ability to assimilate the phosphoric acid held

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by the gel of iron. This problem was cleared by a series of experiments, which was conducted with several agricultural plants according to a method of sand cultures. Experiments were conducted with winter wheat (Lutestsens 329), with beans (Triumph), sunflower (Kruglik), gambo hemp (Variety 1204) and Italian hemp grown in Prianishnikov's nutritive solution. The action of phosphoric acid, held by the gel of iron (the same preparation which served us for the experiment cited (sentence continues on page 206) [Begin p.205]

Table 75 on a separate page

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Differences of individual agricultural crops in regard to the ability for absorption of sorptionally held phosphoric acid.

Variants of the experiment	Dry weight of plants in g per vessel	Increase in weight compared to control		Content of P_2O_5 in the crop in mg per vessel	Increase of P_2O_5 compared to control		Dry weight of plants in g per vessel	Increase in weight, compared to control		Content of P_2O_5 in the crop in mg per vessel	Increase of P_2O_5 compared to control	
		in mg	in relative amounts		in mg	in relative amounts		in mg	in relative amounts		in mg	in relative amounts
	Corn						Beans					
Without P_2O_5 (control)	4.9	-	-	13	-	-	2.9	-	-	9.6	-	-
$CaHPO_4 \cdot 2H_2O$	36.5	31.6	100	201.1	187.9	100	18.0	15.1	100	40.2	30.6	100
Gel of iron	21.5	16.6	52	67.1	55.9	29	7.7	4.8	32	16.0	6.4	21
$Ca_3(PO_4)_2$	-	-	-	-	-	-	-	-	-	-	-	-
	Sunflower						Winter Wheat					
Without P_2O_5 (control)	2.2	-	-	2.8	-	-	3.9	-	-	4.5	-	-
$CaHPO_4 \cdot 2H_2O$	32.1	29.9	100	77.9	75.1	100	13.2	9.3	100	38.3	33.8	100
Gel of iron	21.6	19.4	65	34.9	32.1	43	9.8	5.9	63	22.8	18.3	54
$Ca_3(PO_4)_2$	-	-	-	-	-	-	11.1	7.2	77	24.9	20.4	60
	Hemp						Gambo Hemp					
Without P_2O_5 (control)	0.2	-	-	-	-	-	0.6	-	-	-	-	-
$CaHPO_4 \cdot 2H_2O$	45.3	45.1	100	-	-	-	62.9	62.3	100	-	-	-
Gel of iron	12.3	12.1	28	-	-	-	10.1	9.5	15	-	-	-
$Ca_3(PO_4)_2$	41.6	41.4	96	-	-	-	18.8	18.2	29	-	-	-

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earlier in an experiment with corn) was compared with the action of disibstetuted calcium phosphate ($CaHPO_4 \cdot 2H_2O$), used in Prianishnikov's solution, and for certain crops also with trisubstituted phosphate $Ca_3(PO_4)_2$, another representative of the difficultly soluble sources of phosphoric acid for the plants. Dose of P_2O_5 in all experiments was decreased 2-3 times compared to norms of Prianishnikov.

Results of these experiments are shown in table 75; for a fuller picture the just now cited experiment with corn was also included in the table.

From an analysis of data of the table it is seen that the plants in question differ quite substantially among themselves in their ability to assimilate phosphoric acid which is held by the gel of iron. To the number of plants which assimilate easily belong winter wheat, sunflower and, partly, corn (taking their average yield); to the number of difficultly assimilating belong gambo hemp, hemp and beans.

Further on, from the table is seen, that an ability for assimilation of phosphoric acid from the gel of iron does not coincide (more correctly, does not necessarily coincide) to the ability for its assimilation from another, difficultly available source of phosphoric acid - trisubstituted calcium phosphate, which was taken into the experiment. It is especially clearly seen in a comparison of data of gambo hemp and of the southern hemp (see figures 15 and 16). The first of the named crops reacted weakly to both the difficultly available sources of phosphoric acid, whereas the second crop with only a slight effect from phosphoric acid, held by the gel of iron showed a sharply expressed positive effect from the trisubstituted phosphate of calcium which did not give in to the effect of the slightly soluble phosphate. Finally in the case of winter wheat both the difficultly available

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sources of phosphoric acid were comparatively well assimilated by the plants, and, moreover, in close amounts.

It is quite evident, that at the basis of utilization of phosphoric acid by the plants from these two sources lie two different mechanisms. It was shown by the old works of F.V. Chirikov (1916a, 1918), which were also corroborated by E. Truog (1918), that availability to the plants of phosphoric acid from trisubstituted calcium phosphate or from phosphorite depends in the closest manner on the intensity of absorption by plants, on the one side, of calcium ions, and, on the other, of phosphate-ions. A high value of ratio of $CaO:P_2O_5$ in a plant usually characterizes a high ability of the plant to absorb phosphoric acid from difficultly soluble phosphates of calcium, and vice versa. Results of our experiments conform fully to this explanation, because hemp occupies an exclusive position in its ability to accumulate calcium in its aboveground organs; it also occupied an exclusive place in showing a positive [Begin p.207] reaction to the introduction of trisubstituted calcium phosphate (the contents of calcium in the sand was equalized for all the variants of the experiment).

As far as the phosphoric acid from the gel of iron is concerned, its dissimilar availability to the plants can be explained, as it was pointed out, by differences in the qualitative and quantitative composition of root secretions and in the vigor of development of root systems of individual plants.

Another possible explanation - a distinct ability of plants for satisfying their needs in phosphoric acid from solutions of such low concentration, as in our case with the gel of iron, - has a smaller basis, because the works of M.K. Domontovich (1928) show that agricultural plants (oats, corn, peas, buckwheat), tested by him, do not

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show any substantial differences in the ability to assimilate phosphoric acid from solutions of low concentration.

Title of figure 16. Availabiltiy to gambo hemp of phosphoric acid from difficultly soluble phosphates. 1 - without phosphorus; 2- with $CaHPO_4$; 3 - with $Ca_3(PO_4)_2$; 4 - with phosphoric acid, absorbed from the gel of ferric hydroxide.

Returning to the problem about the importance of contact between the roots and the adsorbent for the mobilization of phosphoric acid, [Begin p.208] which is held by the gel of iron, it is necessary to state that the conclusion which we made about the decisive role of root secretions and the slight role of contact exchange by no means speaks against the importance of this contact.

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Title of figure 16. Availability to Italian hemp of phosphoric acid from difficultly soluble phosphates.
Legends are similar to those in figure 15.

Nevertheless, in this case the question is not about the contact exchange, but about the contact absorption as K.A. Timiriazev, N. Comber, E. Truog and F. Parker saw it; that is about the absorption of substances under conditions of a closed system a root hair - a colloidal particle.

Exactly under conditions of such a contact organic root secretions are directly heading for the colloidal particles which contact the roots, avoiding their being diluted by the soil solution, as well as undergoing a smaller risk of being utilized by soil microflora.

At such an interpretation of the mechanism of contact absorption, the vigor of development of the root system, the size of the surface [Begin p.209] of the active rootlets and root hairs, which are able to

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produce this "cemented" contact with colloidal particles, must emerge in a role of a factor in assimilation by the plants of sorptionally held phosphoric acid no less substantial, than if contact exchange would lie at the basis of this mechanism.

This idea can be illustrated by the results of a special experiment, which was directed to clarifying the role and importance of the vigor of development of the root system for absorption by the plants of phosphoric acid from two of its, such sharply different sources, as the disubstituted calcium phosphate and the gel of iron with the absorbed phosphoric acid.

Considering the results of the above cited laboratory experiments, which showed a noticeable solubility in water of the calcium phosphate in question, which was increased still more (5 times) under the influence of carbon dioxide, one could expect that the action of this phosphate on plants will show a smaller dependence on the vigor of development of the root system, than the action of phosphoric acid, held by the gel of iron.

In the cited experiment the vigor of development of the root system was regulated by a change in intensity of lighting of aboveground organs during the process of plant growth. The importance of this factor for the development of the root system is ascertained by a series of researches, including also our work with Indian hemp (Rather and Markovich, 1938).

A choice of an experimental plant has here a substantial meaning, because in the case of light-loving plants a decrease of intensity of lighting through the means of shading, leads to suppression of growth of

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the root system alone, but also of aboveground organs, and leaves in particular.

We chose beans (variety "Triumph"), as a plant comparatively tolerant to shade, enduring, as it was shown in works of N.A. Maksimov, E.B. Lebedintseva and G.A. Krasnosel'skaia - Maksimova (1924) a certain shading without harm to the growth of aboveground organs, but with a noticeable suppression of the root system growth.

The experiments were conducted in sand cultures utilizing Prianishnikov's nutritive solution with an addition of boron and manganese. The dose of phosphoric acid was decreased 6 times compared to Prianishnikov's norm (100 mg of P_2O_5 per vessel with 7 kg of sand). Thus the plants were grown in an evident deficiency of phosphoric acid. During thinning three plants were left in each vessel.

In the experiment there were two series of vessels with plants. One series was kept on an open wagon, which stood all day long on an open terrace, which adjoined [Begin p.210] the vegetative house, while the other series was placed on the same landing in a wagon, which was covered with a double layer of gauze stretched over an especially constructed wooden framework. Watering and care for the plants was conducted by opening the gauze on the northern side.

During the whole vegetative period sampling was conducted systematically to determine the relative intensity of lighting according to the method of Meier and Bering (by the amount of separated iodine from a mixture of 25 cc of 1% solution of potassium iodide and 25 cc of 6.8% solution of sulfuric acid). These evaluations have shown, that if one takes the intensity of lighting over the open wagon as 100 ("normal" lighting) then on the shaded wagon it comprised: over the plants 67%, and among the plants 64% of the normal.

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The experiment was conducted in summer of 1940 having but a small number of cloudy days. The experimental plants were harvested on August 6. The weight of roots was accounted for after they were washed clean from sand.

Results of the experiment are given in table 76.

In the table data showing the weight are given in fractions. The numerator shows the absolute air-dried weight in g per vessel, and the denominator the same thing in relative amounts, taking data for corresponding variants without shading as 100.

Table 76.

Influence of shading on the effectiveness of various forms of phosphoric acid.

Variants of the experiment	Weight						Increase of weight compared to the control	
	of roots	of stems	of leaves	of beans	of the whole above-ground mass	of whole plants	of above-ground mass	of whole plants
Without phosphorus, without shading	0.98	0.61	1.34	-	1.95	2.94	-	-
$CaHPO_4 \cdot 2H_2O$, without shading	4.67 / 100	5.48 / 100	6.04 / 100	2.84 / 100	13.36 / 100	18.02 / 100	11.41 / 100	15.08 / 100
The same, with shading	3.06 / 65	5.45 / 99	6.58 / 150	3.72 / 131	15.75 / 118	18.81 / 105	13.80 / 121	15.87 / 105
Gel of iron, without shading	2.47 / 100	2.01 / 100	2.54 / 100	0.72 / 100	5.27 / 100	7.74 / 100	3.82 / 100	4.80 / 100
The same, with shading	1.65 / 66	1.40 / 70	2.35 / 92	0.59 / 82	4.34 / 82	5.98 / 77	2.39 / 72	3.04 / 63

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Results obtained show that shading of plants showed quite different effects, depending on the form of phosphate. In the case of phosphate of calcium, which is easily available and easily mobilizable under the influence of hydrolysis and of carbon dioxide the lowering of the intensity of light, which caused a decrease in weight of the root system one and a half times, it did not affect negatively the growth of aboveground organs, but even augmented their weight and raised the increase from phosphate by 21%, compared to increase from that same phosphate in the absence of shading. This corresponds to the nature of beans as a comparatively shade-loving plant.

Quite different results were obtained in variants of the experiment with phosphoric acid held by the gel of iron. In this case decrease of weight of the root system under the influence of shading also was reflected negatively by one and a half times on the growth of the aboveground organs, in consequence of which the increases from phosphate in the case of shading were lower in the aboveground mass by 26% and by 37% in the general weight, than the increases in the absence of shading.

It is quite possible, that the noted effect depends not only on the decrease of the size of the root system, but also on the change of its biochemical composition under the influence of shading (in particular, decrease of sugar content, which was stated by us in the above cited work with Indian hemp). In any case, from the above described experiment, it issues with certainty that for absorption by plants of phosphoric acid, which is held by the gel of iron, the active reaction of the root system, which is guaranteed by its sufficient development and by a corresponding biochemical composition, arises in a role of a more vigorous factor, than in a case of absorption of phos-

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phoric acid from the easily available, slightly soluble calcium phosphate.

Thus, regardless of the fact that we did not succeed in establishing the role of contact exchange in absorption by plants of phosphoric acid, which is held by the gel of iron, the importance of contact between the roots and the absorbent, the fullness of utilization of the substratum by the root system of the plants - emerge also in relation to phosphate-ions as a vigorous factor, determining the availability of sorptionally held nutritive substances for the plants.

In the light of the above cited it is possible to hold as justified the tendency of some authors (Klechkovskii, 1945) to consider a favorable action of lime on the process of phosphorous feeding of plants on acid soils not just as a result of change of mobility of phosphoric acid in the soil, but as a result of improvement of conditions for development of roots and increase in surface contact between assimilating rootlets and particles [Begin p.212] of the soil. The fact, ④ about a sharp decrease of absorption by plants of difficultly available phosphoric acid from the soil, which is characterized by a surplus of sesquioxides, with a reduction of the size of the root system under the influence of the onesided nitrogen-potassium fertilization also becomes understandable.

④ Which was pointed out by us(Ratner, 1948).

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5. On the nature of absorption by plants of non-exchangeable soil potassium.

Finishing the examination of the problem of the activity of plants in absorption of mineral substances from the solid phase of the soil and of the importance of contact between the roots and the particles of soil for the manifestation of this activity, we think it necessary to briefly stop and investigate the nature of absorption by the plants of non-exchangeable potassium of the soil.

This problem presents an exceptional interest, because at a low content of exchangeable potassium in the soil the plants quite often satisfy their need in this cation to a noticeable degree, and sometimes fully, by utilizing the non-exchangeable potassium of the soil.

A.T. Kirsanov's (1940) research has shown that with a content of 7-8 mg of free (basically exchangeable) potassium per 100 g of soil, which was calculated according to the author's method, the plants absorbed from this source only 15-20% from the total amount of potassium contained in it; the rest was absorbed at the expense of non-exchangeable potassium of the soil. Even when the soil contained 15 mg of free potassium, two thirds of potassium, absorbed by the plants, were drawn from its non-exchangeable form in the soil.

It is true, that in the work of A.L. Maslova, A.A. Stoliarova and A.V. Uvarova (1952) a negative answer is given to the problem about the ability of plants to assimilate the non-exchangeable potassium of the soil; nevertheless, the results of their experiments can be explained by the peculiarities of the procedure used by them. In order to remove exchangeable potassium the authors actually washed it with

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after
solutions NaCl or NH_4Cl, and ~~stmx~~ that, they introduced this soil, which was fully saturated with sodium and ammonium, as a source of potassium for the plants. From all the above cited by us earlier it is clear that saturation of the soil to 100% with sodium or ammonium could not create favorable conditions for assimilation of soil particles by the plant roots and for their successful absorption of potassium from such a fixed source, as the non-exchangeable potassium of the soil.

Later works of several authors, which were only partly quoted by us in chapter II, including also works of the just mentioned A.L. Maslova (1938) and A.A. Stoliarova (1940), do not leave [Begin p. 213] any doubt that in many soils (not in every one and not always) when in them there is a low content of exchangeable potassium, the plants can, to a considerable degree, satisfy their need in this cation by utilizing the non-exchangeable potassium of the soil. Together with this one should recognize, that on some soils exchangeable potassium can be transformed into non-exchangeable, or only slightly available form to the plants (Nikishkina, 1941).

What is then the nature of absorption by the plants of non-exchangeable potassium of the soil?

As it was already pointed out, at the present time an idea receives more and more recognition about the fact that at the basis of utilization by plants of non-exchangeable potassium of the soil lies a free equilibrium between the exchangeable and the non-exchangeable potassium during which, together with the utilization by plants of the exchangeable potassium, proceeds a renewal of its content in the soil at the expense of the "inflow" of non-exchangeable potassium from the inner

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layers of the soil particle to its outer surface, where it becomes exchangeable. Thus, according to these opinions, the nature of absorption by plants of non-exchangeable potassium of the soil in its essence is the same as is the nature of absorption of exchangeable potassium.

Also, probably, in favor of this assumption are the facts about "regeneration" of exchangeable potassium in the soil when it is in fallow and, to a greater degree, after using it for growing plants (Barbier, 1932; Abel and Magistad, 1935; Maslova, 1938; Chandler, Peech and Chang, 1945).

One should say, though, that there are not any convincing proofs showing that plants use non-exchangeable potassium only after its passing over into an exchangeable form; meanwhile our research into the influence of the composition of exchangeable cations in the soil on the availability to the plants of exchangeable and of non-exchangeable potassium compels us to withold our acceptance of the point of view, cited above, on the nature of absorption by plants of non-exchangeable potassium of the soil.

Actually, in all our earlier statements were cited numerous examples of sharp lowering of availability to the plants of exchangeable potassium in the soil in its combination with exchangeable sodium, as an accompanying cation. Consequently, if utilisation by the plants of non-exchangeable potassium comes in the end to a subsequent absorption of that its part which becomes exchangeable, then the influence of sodium, as an accompanying cation, must also tell negatively on the absorption by the plants of non-exchangeable potassium of the soil. Meanwhile, when studying table 14 (see p.57) we saw, that entrance of sodium into the composition of exchangeable cations of the soil sharply decreased

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the availability to the plants of exchangeable potassium, without producing any influence on the availability to them of the non-exchangeable form of this cation. [Begin p.214]

Moreover, further experiments showed that in certain cases the saturation of the soil with sodium up to a certain, comparatively high level, but which is yet harmless to the plants, leads even to a considerable increase in availability to the plants of non-exchangeable potassium of the soil.

We obtained such a result in an experiment with Batumskii red soil in saturating it in one case to 83% of Ca + 17% of Mg, in another case - to 63% Ca + 17% Mg + 20% Na, and in the third case to 43% Ca + 17% Mg + 40% Na. The sum of exchangeable cations was equal to 16.5 meq per 100 g, PpH of the soil in the water suspension ranged from 6.2 to 6.6. The soil contained a negligible amount of exchangeable potassium (4 mg per 100 g when evaluated according to Peive method).

As it follows from data of A.T. Kirsanov (1940) which were cited earlier, with such a content of exchangeable potassium the plants absorb basically all their potassium from the non-exchangeable forms in the soil.

Samples of soil were added in quantities of 100g per 900 g of sand. Wheat of the variety "Moskovskaia 2411", was planted in an amount of 80 seeds for each vessel. Harvesting was done in 17 days. Results of the experiment are given in table 77.

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Table 77.

Influence of the composition of exchangeable cations in the soil on absorption by plants of non-exchangeable potassium of the soil

Composition of exchangeable cations in the soil	Dry weight of plants in g per vessel	Content in plants of potassium in mg per vessel	Potassium absorbed from the soil	
			in mg	in % from the 1st variant
Sand (control)	1.90	11.81	-	-
83% Ca + 17% Mg	1.94	22.87	11.66	100
63% Ca + 17% Mg + 20% Na	2.34	24.30	12.99	112
43% Ca + 17% Mg + 40% Na	2.20	36.03	24.82	215

As seen from the above data replacement in the soil of 40% exchangeable potassium with sodium doubled the amount of potassium absorbed by the plants. Yet from table 17 (p.65) we saw that in respect to exchangeable potassium on the same soil enrichment of it with exchangeable sodium sharply lowers the availability of this potassium to the plants. [Begin p.216]

Although a positive effect in the influence of the exchangeable sodium on the availability to the plants of non-exchangeable potassium of the soil does not always appear (often it turns out to be negative), yet the fact itself about the possibility in certain cases of an opposite influence of the exchangeable sodium on the availability to the plants of exchangeable and non-exchangeable potassium of the soil speaks against a tolerance of passage of the non-exchangeable potassium into an exchangeable form, as a necessary intermediary step in its absorption by plants.

We think that at the basis of absorption by plants of non-exchangeable potassium of the soil lies the breakdown, under an active reaction of the plant root system, of a certain, the least stable, the

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most labile part of the colloidal complex of the soil in the zone of contact between the root hair and the soil particle, and a direct utilization of the thus liberated potassium without its transition into an exchangeable form; that is before its absorption by other soil particles. It is precisely this circumstance which allows the plant to successfully utilize the non-exchangeable potassium from the soil also under conditions of its high saturation by sodium. (1)

(1) I would remind you, that the total content of potassium in the soil usually exceeds by hundreds of times the content in it of exchangeable potassium, that is why it is enough to break down the very smallest part of colloidal complex of the soil in the zone of contact with roots in order to free noticeable amounts of potassium for the plants.

On the other hand, the facts which we mentioned in chapter II about a comparatively fast transition, under the influence of various agents, of the exchangeable form of potassium into the non-exchangeable form, which were also stated in regard to magnesium (Antipov-Karataev and Antipova-Karataeva, 1936) picture to us a possibility of regeneration of these labile, weakly-stable potassium and magnesium - containing colloidal minerals in processes of conversion of different forms of these cations in the soil.

We see evidence for this point of view in a fact, that absorption of non-exchangeable potassium of the soil by a plant takes place only under conditions, which guarantee the possibility of a closed contact between the root hair and the soil particle, when the root secretions are directly aimed at soil particles, adjoining the root hair before dilution of these secretions by the soil solution can take place or before their utilization by the soil microflora.

We already pointed out that, actually, during reaction of roots with soil suspension, when constant stirring was done, there was not a single case (and we conducted dozens of experiments) where we discovered absorption by the plants of potassium from a soil which lacked this cation in an exchangeable form. In these experiments the

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duration of reaction of the roots with soil suspensions did not exceed 48 hrs. Yet further special experiments [Begin p.216] showed that the idea pointed out remains correct and with far longer periods of reactions of roots with soil suspensions.

In table 78 are given data of one of such experiments with barley, variety Viner 1163, of three weeks growth, which was characterized by a comparatively low initial content of potassium and having, as a consequence of this, a highly expressed ability for absorption of potassium from the outside medium even at its light saturation of the colloidal complex of the soil.

The plants, after their roots were washed clean from the nutrient solution, were placed for 4 days into a suspension of an average chernozem from Kamennoi steppe, saturated in one case to 100% of Ca, and in another to 30% Ca + 70% Na. The suspensions contained 100g of soil in two liters of water. The suspensions were aerated every hour for 5-10 min. Besides this, the contents of the vessels were regularly stirred with a glass rod, having a rubber paddle. Plants, which were placed into distilled water for the same period of time and under the same conditions, served as control.

Results of the analysis of plants for the content in them of potassium are given in table 78.

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Content of potassium in plants (barley Viner 1165) after a four-day reaction of roots with the suspension of the soil.

Variants of the experiment	Dry weight of plants in g per vessel	Content of potassium in plants	
		in % of the dry plant material	in mg per vessel
Plants were placed: into distilled water (control).	7.91	2.342	185.0
into soil suspension, saturated to 30% of Ca + 70% Na.	8.34	1.796	149.8
Same, to 100% of Ca.	8.12	2.307	188.8

As it is seen from an examination of this table, the plants, also during this lengthy period, were not able, under conditions of the experiment, to extract from 100 g of chernozem soil not one single mg of potassium irrespective of the composition of the exchangeable cations in the soil (during a high saturation of the soil with sodium, as well as under conditions of a short duration experiment, desorption of potassium by the soil from the plants is revealed).

[Begin p.217]

A similar picture with the same soil, saturated to 100% Ca, to 70% of Ca and 30% H and to 70% of Ca and 30% Na, was obtained with soy beans, variety Amurskaia 154, grown with a minute content of potassium in the nutrient solution and taken into the experiment after 15 days of growth. Duration of the experiment here also comprised 4 days. Plants, which underwent analysis before the experiment, served as control. Results of the experiment are shown in table 79.

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Table 79

Content of potassium in plants (soya Amurskaia 154) after a 4 day reaction of roots with the suspension of soil.

Variants of samplings	Dry weight of plants in g per vessel	Contents of potassium in plants in mg per vessel
Before the experiment (control).	2.95	48.85
After reaction with suspension of the soil saturated:		
to 100% of Ca	3.44	44.61
to 70% Ca + 30% H	3.61	46.16
to 70% Ca + 30% Na	3.54	42.80

In this experiment also, after a period of 96 hrs the plants were not able to extract from the soil, which was deprived of exchangeable potassium, any noticeable amounts of this cation.

And yet, in the presence in the self same soil of exchangeable potassium, especially in the absence among accompanying cations of sodium, the plants, as we saw it repeatedly, under the same conditions of the experiment intensively absorb this potassium from the soil even during a very short period of time (several hours).

Data, cited in this section are yet insufficient for somewhat broad generalizations, but they permit one to assume that absorption by plants of non-exchangeable potassium appears to be a result of an active reaction of plants with the colloidal complex of the soil, which is gradually being realized in time under conditions of close contact between the roots and the particles of soil. It seems that the result of this reaction apparently is a breakdown of a certain part of potassium - containing colloidal minerals in those parts of soil particles which directly adjoin the active elements of the root systems.

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A fact, pointed out by us, about the increase in certain cases of availability to the plants of non-exchangeable potassium of the soil at a substantial [Begin p.218] increase of the rate of saturation of it with sodium can be explained by a widely known circumstance from the works of K.K. Gedroits, that under the influence of exchangeable sodium the soil becomes more vulnerable in regard to reaction of various destructive agents owing to the heightening of its degree of dispersion. The plant root secretions are not necessarily the only such destructive agents; it is quite possible that a certain role is played here by rhizospheric microorganisms which are developing on the foundation of these root secretions. It is known what great importance V.P. Williams (1947) ascribed to the reaction of products of the vital activity of fungi and bacteria on the mineral frame of the soil. Research of B.B. Polynov and of his co-workers (Polynov, 1945) have shown that even the first stages of soil formation on the massive-crystalline rocks, which were usually looked upon as sterile processes of wind erosion, are linked to the vital activity of organisms, which, in the end, includes destruction of the silicon-alumina nucleus of alumino-silicates.

V.I. Vernadskii has persistently pointed out the role of living matter (bacteria and diatoms) in decomposition of silicates and alumi-nosilicates. He attached great importance to this biogeochemical process in nature's economy. "This reaction", wrote V.I. Vernadskii, "in its importance and in its character resembles another, still more geochemi-cally important: destruction of such stable molecule, as CO_2 and H_2O by the green living matter in chlorophyll plastids" (Vernadskii, 1927, p.140).

V.I. Vernadskii's ideas about the presence in nature of specialized "silicate" bacteria have of late found experimental confirmation in

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works of N.P. Remesov (1947), L.E. Novorossova, N.P. Remezov and N.N. Soushkina (1947), showing an ability of bacteria, which were obtained in cumulative cultures of podzolic soils and of soloth, for destruction of a series of natural minerals and rocks-- microclines, olivine rocks, kaolinite, biotite and feldspar. A slimy bacillus, which was isolated in this research, and was found in considerable amounts in all retorts, where minerals underwent decomposition, was capable in experiments with microclines to decompose it.

All these facts and considerations cause us to admit that in the region of the rhizosphere the solid phase of soil, which includes different potassium - containing silicates and aluminosilicates, undergoes a considerable reaction on the part of biological agents. As an outward manifestation of this reaction from the biological agents one must reckon the accumulation in the soil, under the influence of vegetation, of free (non-silicate) sesquioxides, which [Begin p.219] according to Tiulin (1946), are the result of decomposition of minerals in root microzones. As seen from a comparative study, conducted by V.M. Klechkovski (1947) on group composition of soil colloids in podzolic soil of Moscow Agricultural Academy im. K.A. Timiriazev, on a permanent fallow and on sections, which were under cultivation for 32 years, results of biological weathering, under the influence of vegetation, found already in this comparatively short period a clear expression of an increase in the contents of the soil of the so-called " "melkozem" of the 2nd group [melkozem are particles of soil finer than 0.25 mm], according to Tuilin (that is, particles which are enriched with free sesquioxides]. Undoubtedly, all these facts are very closely bound to the problem of utilization by plants of non-exchangeable

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potassium of the soil. (1)

(1) The works of V.G. Alekxandrov (1949, 1949a), which were published only lately, gave an experimental confirmation to the possible role of "silicate" bacteria in improvement of conditions of potassium feeding at the expense of decomposition in the soil of potassium - containing silicates and aluminosilicates. It is interesting, that according to data of this researcher, the "silicate" bacteria, which were isolated by him, belong to the number of rhizospheric microorganisms, which points to the closest bond of the process of mobilization of soil potassium by these bacteria with the vital activity of the higher plant.

The question about the nature of absorption by plants of non-exchangeable potassium of the soil acquires an exceptional importance for an understanding of conditions of potassium feeding of a plant in the process of its ontogenesis. As it was seen from experimental data, given in chapter III, the exchangeable potassium, in its usual low rate of saturation of the soil, can be taken as a real source of potassium for the plants only in the early phases of their development. In later phases of plant development this source of potassium already becomes for them difficultly available, or even quite inaccessible. Under these circumstances comes forward the role of non-exchangeable potassium, availability of which to the plants must grow in later phases of plant development with an increase of exosmosis of organic substances in root secretions.

In the light of all the above said one should state anew, that methods of evaluation of available potassium in the soil and ways of reaction to conditions of potassium feeding of plants cannot be decided apart from ontogenetic changes in the activity of plants during its reaction with the solid phase of the soil.

In conclusion let us point out, that on the basis of data, given in the present chapter, we came to the conclusion, that the value of a

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contact between the active part of the root system and the soil particles is by no means limited to a possibility of contact [Begin p.220] exchange by ions under these conditions. Contact absorption is a wider idea, than just contact exchange. The last one comprises only one of the elements of the contact absorption, the importance of which, as we saw it, is radically determined by the status of nutritive substances in the soil, and, first of all, by a degree of their mobility.

This all brings us back to an old truth, which was so brilliantly defended by K.A. Timiriazev, about the exceptional importance for mineral feeding of plants under natural conditions of a vigorous development of the root system and a much fuller utilization by it of one or another soil horizon.

It is not necessary to prove how valuable the mastering of this process would be, the possibility to arbitrarily regulate the development of the root system in this or another, desirable to us, soil horizon, on this or that depth from the surface of the soil.

In this respect, to us seems especially promising that direction which is being developed by A. V. Sokolov (1936, 1947) on the basis of the microdynamic method, suggested by him, which establishes a possibility with the aid of fertilizers to draw the roots into one or another soil zone, and with the aid of others - to induce their more vigorous development in that zone.

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Conclusions [of Ch. 4] (p. 220-222)

1. A question about the plant's ability for independent utilization of nutritive substances which were adsorbed by the soil, without their being previously forced out into solution with the aid of an outside agent, must now be counted as solved in a positive sense. Utilization of these nutritive substances is accomplished by way of an active influence of the plant itself on the solid phase of the soil.

2. The mechanism of an active effect of the plant on the solid phase of the soil includes the following: effect of carbon dioxide, which is released by the roots, and of other root secretions, mainly of organic acids; an indirect effect, by means of activating the vital action of certain soil microorganisms in the field of the rhizosphere; shifting of the reaction in the environment of the roots during utilization by the plant of physiologically-acid and of physiologically-alkaline fertilizers, and so on.

3. Under soil conditions, where the basic store of nutritive substances is in an insoluble form, or on a border of a liquid and solid phase of the soil (adsorbed nutritive substances), the chief means for absorption by the plant of nutritive (Begin p. 221) substances from the soil must be regarded as a contact absorption, which is accomplished during a close intergrowth of root hairs and of thin root branchings with particles of soil. Under these conditions all the factors, enumerated in para. 2, of the active effect of the plant on the solid phase of the soil find their stronger expression, because they become localized in a closed system of root hair--soil particle.

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And yet another element of contact absorption, to which K. A. Timiriazev pointed more than 70 years ago, acquired great importance---conversion of nutritive substances from the solid phase of the soil directly into the cells of the root, passing by the surrounding soil solution, as a result of the effect of the cell sap acids on the solid phase of the soil, without their discharge outwards.

6. K. A. Timiriazev's ideas about the mechanism of contact absorption by plants of nutrients from the solid phase of the soil can, at the present time, be fruitfully utilized for comprehending the mechanism of absorption by the plants of exchange cations of the soil. Having in view that the active absorbing surface of the root always contains hydrogen ions, which are capable of exchange and are constantly renewed, as a result of the vital activity of the cells, the nature of this mechanism should be seen in the fact, that during a close intergrowth of root hairs and soil particles, by means of their water films, the plant absorbs cations from the micellar liquid, which is surrounding the soil colloids, exchanging them for hydrogen. This treatment of the nature of contact exchange and of its role in plant feeding seems to us more appropriate to answer the modern state of the problem about the mechanism of absorption by a plant of mineral substances from the surrounding medium, than a presentation by American researchers of "jumping" cations from one absorbing surface to another, without any participation of the liquid phase.

5. The role of contact exchange in plant absorption of exchange cations of the soil acquires a special significance with a low saturation and weak mobility of one or another cation of the soil which is

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indispensable to the plant. Under these conditions a concentration of this cation in the intermicellar liquid (soil solution) is inadequate to the physiological requirements of a plant, and the latter one satisifes its need for the cation by absorbing it from a micellar liquid by way of a contact exchange. With a high saturation and high mobility of a given cation in the soil, a contact exchange is not necessary for the plant's absorption, as the effect of carbon dioxide, secreted by the roots in combination with hydrolysis processes is quite sufficient for the upkeep, under these conditions, of a concentration, favorable for the plant, of the given cation in the soil solution. (Begin p. 222)

6. The conducted researches failed to establish a substantial role for a contact exchange in a plant's absorption of sorpted phosphoric acid. Nevertheless the role of contact absorption, in the above cited wide understanding of this term, is quite great in this case also. The effect of organic root secretions, basically of organic acids, should be held as the basic acting factor during the absorption by the plant of sorpted phosphoric acid.

Exceptionally great is the role of contact absorption during plant utilization of the non-exchange potassium of the soil. In this case the contact absorption is accomplished by a direct action of the plant itself on the solid phase of the soil, as well as by an indirect effect on the root activated world of rhizospheric microorganisms, among which a definite place is apparently occupied by "silicate" bacteria, which are capable of decomposing potassium-containing silicates and alumosilicates, releasing potassium in a

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form accessible to plants.

7. All the above cited shows an exceptional significance of the might of root system development, of continuous growth of its surface contact with soil particles as a deciding factor in the plant's utilization of the soil's effective fruitfulness.

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Conclusions [of Ch. 6] (p. 291-295)

1. A basic cause for unfavorable properties of a saline soil, as an agent for plant growth, is the entrance of sodium into the composition of exchange cations of the soil and a decrease of the rate of saturation of the soil by calcium at the expense of its substitution mainly by sodium and magnesium.

Enrichment of soil by exchangeable sodium leads to a sharp change in some of the soil's properties, in consequence of which a problem about the leading factors, which determine the fertility of solonetz and of saline soils during different stages of development of the saline process, require careful physiological analysis.

2. Standard ideas about the leading importance of alkaline reaction of the agent and about formation of soda in the soil, as deciding factors, which determine the toxicity of solonetz to cultivated plants, have in themselves no foundation, especially when applied to non-carbonated, non-soda solonetz, which are most widely spread over the territory of Soviet Union, and which are of greatest interest as objects for agricultural utilization.

3. During the first stages of development of the saline process, when content of exchangeable sodium in the soil is small, a leading role, in determining its properties as an agent for plant growth, belongs to physical properties of the soil, sharply changing to an unfavorable state with the entrance of even small amounts of exchangeable sodium. (Begin p. 292) The content in the soil of exchangeable sodium during these first stages of development of the saline process is not in itself a cause for

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direct negative (more toxic) effect on plants. The basic problem for melioration of these soils must be an improvement of their definitely unfavorable physical properties. Under certain conditions a small content of exchange sodium in the soil can have a positive importance from the point of view of its influence on the mobility of nutritive substances in the soil.

4. As contents of exchangeable sodium in the soil increase, besides the agro-physical factor, cited above, which achieves its greatest expression, there begins to operate also an agro-physiological factor, which is linked to a direct toxic effect of the soil on the plant. The nature of this toxic action can only indirectly be linked to an increase of pH and the possibility of formation of soda in the soil. At its foundation lies a basic dislocation of a balance of cations in plant tissues, which was already examined in previous chapters and which occurs in consequence of a full suppression of availability of exchange calcium of the soil to the plants under such conditions together with an unimpeded absorption by them of exchange sodium.

6. The position of that critical level of soil saturation with sodium, at which begins to appear its direct toxic effect on the plant, depends on the properties of the soil (particularly on its wealth of organic substances), as well as on the properties of the plant, and on a degree of its need for calcium. Thus, for grain crops, having a small requirement for calcium (oats, wheat), a full destruction of sprouts occured only at such rates of saturation of the soil with sodium, when already a desorption of calcium from plants by the soil was noted. Whereas for plants, which are characterized by a high need for calcium (hemp, alfalfa, peas), a toxic effect of the exchange sodium showed considerably earlier.

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6. Influence of exchangeable magnesium, usually richly represented in solonetz, on exertion of toxic properties of a saline soil on plants, cannot be in any way compared to the influence of exchange sodium; nevertheless, by integrating with exchangeable sodium and lowering the rate of saturation of the soil with calcium, exchange magnesium increases the influence of exchange sodium on suppression of the availability to the plants of exchange calcium; that is, it strengthens a manifestation of the basic characteristic, which determines the "toxicity" of a saline soil to the plants.

7. Analysis of regularity of a simultaneous interaction of various parts of the root system and of different soil horizons, which vary in the rate of calcium saturation, uncovers a possible mechanism of a meliorating (Begin p. 293) action by plants which are living on solonetz and on saline soils. The arena of this meliorating action of the life of plants is the field of the rhizosphere, where soil particles clinging to the roots in saline horizons are enriched by calcium at the expense of those of its reserves, which are being drawn out by other parts of the root system from non-saline horizons. In this phenomenon, together with the liberation of calcium, which was accumulated in roots, after their death lies the essence of the process, widespread in nature, of "ostepnenie" [becoming a steppe] or of biological transformation of solonetz. Under practical conditions, a combination of biological melioration with the aid of roots of the perennial grass (legumes-grain) vegetation and of chemical melioration by means of gypsum application, especially where irrigation is practiced as must be counted as the most reliable way of meliorating the solonetz. All these conditions are organically combined in grassland farming which presents

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very powerful means for increasing the fertility of solonets and saline soils.

8. Resistance to solonets and resistance to salt in plants at times do not coincide because at the basis of harmful influence on the plants of solonization and of salinization of soil lie different factors.

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General Conclusions (p. 294-299)

1. Development of a theory about the role of adsorptive processes in the initial stage of absorption of mineral substances by plants from their surroundings has since long ago suggested a thought to the researchers that, under natural conditions, absorption of cations by plants occurs under conditions of the closest interaction of two absorptive systems, the plant roots and the soil colloids, each of which is capable of fixing and of retaining these cations. Out of this ensued a problem of a more detailed study of the nature of those processes which proceed within the system of plants; the soil from the point of view of perception of peculiarities and of mechanism of absorption by plants of the adsorptively fixed nutrients.

2. Researches have shown that the movement of cations, during interaction between the roots and soil colloids is not a oneway process, always going from soil to plants. Direction and intensity of this process is determined as by the state of a plant itself, its activity in the interaction with soil colloid complex, so also by the state of this last one, by its ability to fix and to firmly retain either one of the cations.

3. Among the characteristics of the colloidal soil complex, which determine availability to plants of exchangeable cations, the leading place belongs to the indicator which expresses the rate of soil saturation with these cations.

To each given state of the plant corresponds a definite lowest (critical) saturation of the soil by a given cation, above which the movement of this cation goes from the soil into the plant and below which the movement goes in a counter direction, from the plant into the soil (desorption of cations

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by soil from plants). (Begin p. 295)

4. Position of a point (or zone) of critical saturation depends on the nature of the colloidal soil complex, and, in the first place, on the nature of those cations which accompany the given cation in the colloidal soil complex.

Researches have shown, that a suppression of availability to the plant of a given exchange cation at a decrease of the rate of saturation by it of the colloidal soil complex is expressed the stronger, the more stable is the bond of this cation with the colloidal complex of the soil, and the weaker is the stability of a bond with the complex of its accompanying exchange cation. In consequence of this, a special place in the suppression of availability to the plants of exchange cations (calcium, potassium, magnesium) is occupied by sodium cation, as the least stably held by the colloidal soil complex.

In consequence of that same rule the fall of availability of exchangeable calcium to the plant, as the lowering of the rate of saturation of the soil by it proceeds, is expressed considerably stronger than the fall of availability to them of exchangeable potassium is under the same conditions.

5. The rate of saturation by a cation of a plant's tissue is also of importance for the plant's ability to absorb that cation, besides the rate of saturation by it os the soil. The higher is the saturation of the plant's tissues by a given cation (calcium or potassium), the higher stands the critical level of soil saturation by it, which limits its further movement from the soil into the plant.

This circumstance characterizes the regulating role of the colloidal soil complex in plant nutrition; it determines a substantial difference of conditions of absorption by the plants of nutrients from the soil and from

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an inert medium (water or sand cultures).

6. The roots have the least ability to retain cations from their desorption by the soil, than any other organs of plants. This peculiarity of the root system is in contradiction with its role as an absorbing apparatus of the plant. Overcoming of this conflict is based on the fact, which was brought out through research, that with a lack of readily available nutrients in the root area the satisfaction of the aboveground organs of the plant with these substances is upheld on a comparatively high level at the expense of utter deplition of the roots. And this circumstance, according to rules which were cited in the foregoing paragraph, creates prerequisites for absorbing by roots of cations, needed by the plant, even from the soil which is very lightly saturated by them.

On the other hand, at an abundance of mineral substances in the root environment the saturation by them of the root system grows faster, than the satisfaction of overground organs. This circumstance creates premises, again in consequence of the indicated (Begin p. 296) mechanisms, for lowering the activity of plants in absorption of exchangeable cations from the colloidal soil complex.

7. The exceptional role of exchangeable sodium, as an accompanying cation, in suppressing the availability to the plants of other exchange cations (calcium, potassium, magnesium) is illustrated by that circumstance, that during its high saturation of the soil interaction between the plant roots and the soil colloids, in fixing and retention of the cited cations, adds up for an advantage of the latter ones even in that case when the plant is only slightly saturated with these cations.

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8. Age and phase changes in the plant organism, and changes, linked to them, of colloido - chemical characteristics of plant cells influence also the activity of the plant in its interaction with soil colloids. Aging of the plant, lowering of its activity in absorbing mineral substances even from a water solution, decreases, especially sharply, its activity in overcoming the ability of the colloidal soil complex to fix and retain cations, which are needed by the plant. In consequence of this, the critical zones of soil saturation with these cations for plants in a later phase of development lie considerably higher, than for young plants, which are in the starting phases of development.

9. A detailed accounting of the balance of all cations in the plant before and after a short interaction of roots with a soil suspension, which is highly saturated with sodium, shows that the indicated changes of plant's activity, according to age, in their interactivity with plant colloids are linked to changes in the character of the plant's ion exchange with the environment. In young, metabolically active plants this exchange proceeds basically at the expense of hydrogen, which is abundantly formed in cells during the process of metabolism. Consequently the activity of such plants in absorbing cations from the surroundings is high, but desorption of cations from such plants, especially from overground organs, is hampered.

In plants of a later age interchange with the environment basically proceeds at the expense of metallic cations, which previously entered the plant. Participation of hydrogen in this activity is negligible. Consequently, the activity of such plants in the interaction with soil colloids is lowered.

10. A high activity, characteristic to young plants, in absorption of exchange cations from the soil can suffer great changes under the influence

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of external factors. Changes, produced by wilting during a moisture deficiency, can serve as an example.

As researches have shown, the plants which suffered wilting, even after being supplied with water (Begin p. 297) and restoring the turgor of leaves, have a sharply lowered ability for cation absorption from a solution, and, especially so, from the colloidal soil complex. In consequence of this the critical level of plant saturation with potassium lies, in the case of plants which underwent wilting, much higher, than in a case of plants with a normal water supply.

11. A mechanism of plant absorption of adsorptively fixed nutrients includes some components, among which a well-known place belongs to direct interchange of ions between plant roots and soil colloids during their close contact (contact exchange). Researches have shown that the role and importance of contact exchange in the general mechanism of plant absorption of exchange cations grows according to a decrease of the degree of mobility of these cations on the adsorbent.

12. The importance of contact between the plant roots and particles of soil is not limited to the possibility of contact exchange of ions. Under conditions of a closed system, a root hair - a soil particle, the effect of the plant on the solid phase of the soil with the aid of its root secretions acquires great importance. In some cases, for instance during absorption of exchangeable cations from the soil, which is highly saturated by them, a deciding influence among these secretions belongs to carbon dioxide; in others, for example at the absorption of phosphoric acid, absorbed on the gel of ferric hydroxide, to organic root secretions, basically to organic acids.

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13. Activity of the plant in its effect on the solid phase of soil finds its expression also in a wide spread phenomenon, of utilization by plants of non-exchangeable forms of potassium and magnesium from the soil.

Researches, made by the author, impel one to renounce the accepted ideas of utilization by the plants of non-exchange potassium from the soil as a result of gradual migration of this cation to the surface of colloidal particles where it then becomes exchangeable potassium. The essence of this phenomenon should be looked for in the active effect of the plant on the soil particles in a zone of contact with the roots, leading to destruction of a certain part of the least stable potassium - containing components of the colloidal complex of the soil. This can explain the facts, uncovered by us, of the contrary influence of exchangeable sodium on the availability of potassium in an exchangeable form to the plants on the one hand, and of its non-exchangeable form on the other.

Thus, summing up the statements of paras. 11-13, it is possible to say that the essence of the contact absorption of nutrients by plants from the soil is not exhausted by far by the phenomena (Begin p. 298) of contact exchange, the importance of which in the mineral feeding of plants is, undoubtedly, overestimated by American researchers.

14. A combination of above established peculiarities in the influence of exchange sodium on the availability to the plant of other cations from the solid phase of the soil corroborates our, long defended by us, opinion about the physiological meaning of the saline condition of the soil and about the nature of "toxic" influence of solonetz soils on many higher plants.

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On the basis of our research the leading role in these phenomena must be ascribed to the sharply expressed potassium starvation of plants on account of increased entrance into them of sodium, and, in certain cases also, of potassium, with all the aftereffects, issuing from this, for the balance of cations in plant tissues. A deciding influence of this factor appears also in the absence of an alkaline reaction of the agent. Under conditions of an alkaline reaction its negative influence on the plant becomes still more intensified.

15. Together with suppression of availability to the plants of exchangeable potassium, the entrance of sodium into the composition of exchange cations of the soil leads also to a sharply expressed deterioration of the soil's physical properties. During the first stages of development of the saline process, when the contents of exchangeable sodium in the soil are small, and the suppression of availability to the plants of exchangeable potassium is not yet very strongly expressed, a leading place in determining the properties of the soil, as an agent for the growing of plants, belongs to this factor (physical characteristics of the soil). With a further increase in contents of exchangeable sodium in the soil, and an ulterior deterioration of physical characteristics of the soil, a greater importance begins to be acquired also by the physiological factor, which is linked with the change of balance of cations in plant cells. Boundaries of exposure of this factor depend on the properties of the soil, as well as on the characteristics of the plant itself, and in the first place on the degree of its requirements of potassium.

16. The manner for working out methods for melioration and fertilization of solonets for different agricultural crops are determined by facts cited above. In particular, research has shown a possibility of utilization

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of high reactive ability of the soil, which contains exchangeable sodium, for the increase of availability to the plants of phosphoric acid of the difficultly soluble phosphates (phosphorite and of phosphates of sesqui-oxides).

A substantial factor in development of solonetz soil both under natural conditions, and also under conditions of cultivation, is the meliorating action of a living plant on solonetz, proceeding in the zone of contact between the roots and the particles (Begin p. 299) of soil. This meliorating action of a live plant is based on those mechanisms of cation exchange between a plant and soil colloids which where considered above and which foresee a possibility by the plant to force out sodium from the soil particles adjacent to the roots at the expense of replacing it by hydrogen (young plants) or potassium, drawn out from deeper horizons of soil (more mature plants).

Under practical conditions as a more reliable way of solonets amelioration must be held a combination of biological amelioration, with the aid of roots of perennial legumes-grains vegetation, together with the chemical amelioration - through gypsum applications, especially where irrigation is practiced. All these elements are organically combined in grassland farming, which is a powerful means for increase of fertility in solonetz and in saline soils.

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Translation A-737
(In full)
bn/M

Rokhlin, M. I.

Neotlozhnye zadachi proizvodstva khimicheskikh sredstv zashchity rastenii.

[Urgent problems in the production of chemicals for plant protection.]

Khim. Promysh., no. 8, pp. 1-5, Dec. 1955. 385 R523

(In Russian)

A 737

Utilization of chemical preparations in agriculture is expanding every year. Products of chemical industry are used not only as fertilizers, but also for the control of pests and pathogens of diseases of agricultural plants (insecticides, acaricides, fungicides), for control of weeds (herbicides), for artificial defoliation of such plants as cotton and others (defoliants), for plant-growth substances (stimulators), for preplanting treatment of seeds (disinfectants), for prevention of disintegrating activities by microorganisms (antiseptics).

Agriculture suffers tremendous losses from pests and plant diseases.

It is sufficient to remind of such pests as Colorado potato-beetles, eurygasters, leaf-roller moths, aphids, cotton cutworm moths, beet Curculionidae, various scale insects, and so on. The Colorado potato-beetle, with three generations per season, gives progeny of over 50,000,000 individuals, which can consume more than 20 t of green mass of potatoes. A mass growth of eurygaster bugs can lead to a full destruction of a wheat crop; apple leaf-roller moths decrease the value of the yield by more than two times; beet Curculionidae destroy sugar beet plantings in

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their entirety; many centners of cotton are carried away by cotton pests, and so on.

As big a loss for agriculture is brought about by plant diseases. Such diseases as rusts and blights of grain crops, apple scab, grape mildew, ascochyta leaf blight of grain-legumes, and others can, in the absence of their systematic control, bring a great loss and considerably lower the yielding capacity.

One should remark, that various insects do great harm also to livestock, decreasing the yield of milk, lowering the fattening of cattle and damaging the pelts.

Infestation of sowings of cultivated plants by weeds leads to large losses, as the weeds use up for their growth the nutritive substances found in the soil, as well as moisture, and by this retard the growth of cultivated plants.

At present for eradication of weeds in a mechanical way, it is necessary to carry out very expensive and labor consuming works. Here too comes to the rescue the chemical treatment--utilization of herbicides of selective action.

Different chemical compounds are utilized with the aim of averting the premature falling off of fruits, retarding the blooming, retarding potato sprouting in storage, hastening the process of plant rootings, when they are being propagated by slips.

Wide use of chemical substances and their proper utilization gives a possibility to effectively control crop losses produced by pests, diseases and weeds, to considerably increase the yielding capacity of almost all agricultural crops, and to lighten the work and sharply in-

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crease its productiveness. (Begin p. 2)

Thus, according to experimental data, utilization of DDT increases the yield of alfalfa seeds 4 times, and the use of poison-chemicals for control of pests and diseases of cabbage increases its yield by 8 t per ha. Use of herbicides of selective action for the control of weeds gives an increase in the yield of wheat of 2-4 c per ha. Virtually it is computed, that chemical substances for the protection of plants can conserve about 10% of the yield of grains and up to 20% of the yield of vegetable crops.

Chemical industry must in the next 2-3 years double the production of poison-chemicals, in particular of such preparation as DDT and of hexachloran, which, as dusts and emulsions, are widely used for destruction of sucking and chewing insects and various pests of grain, fruit and vegetable crops.

It should be marked, that although the production of DDT and of hexachloran in USSR has grown for the last 6-7 years by 20-30 times, the volume of production does not as yet satisfy the growing needs of agriculture, of health protection, forest economy, and so on.

Before the chemical industry stands a problem to fully satisfy the needs of agriculture in preparations which are required for an intensive control of pests and of pathogens of agricultural plant diseases, for eradication of weeds, for utilization of "defoliation" methods, for stimulation of plants' growth.

Execution of this problem calls for a sharp expansion of the rate of production of such chemicals as DDT, hexachloran, granosan, 2.4-D, and others, already established in agriculture; for improvement of their qualities and amplification of the assortment of the basic prepara-

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tions.

No less important is the broadening of the assortment of poison-chemicals, which are put out by the chemical industry, and introduction into agricultural practice of new, more effective mediums; and first of all of phosphorus organic preparations, which guarantee a successful control of those pests and diseases against which we do not as yet have any fully effective agents.

DDT (dichlordiphenyltrichlorethane) is one of the basic modern insecticides. Although the insecticidal properties of this preparation were discovered in 1937, the beginning of its practical utilization for health protection and in agriculture dates to the years of the Second World War.

In connection with the necessity of increasing the production of DDT at present, it is especially important to utilize all the possibilities for intensification of active productions of DDT and of improvement of the technological process.

Introduction of a continuous method of chlorination of alcohol and use of diluted alcohol in the production of DDT allows to appreciably decrease the norms of output of raw materials and to substantially intensify the process.

For a further increase in the output of DDT it is necessary to liquidate in all active enterprises the existing disproportion between the stages of efficient procurement of chloral and of its condensation, also to achieve on all factories an increase of production per unit of reaction apparatus volume to the rate achieved in leading establishments.

The problem of the manufacturers now is an introduction of contin-

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uously working cascades and of towers of continuous action, accomplishment of automatization of process of alcohol chlorination, of distillation of chlorinated oil, crystallization of DDT.

It is also necessary to strive for full utilization of the basic production waste of DDT-- parachlorobenzolsulfoacid, which would essentially improve the technical-economic production indicators. One of the possible ways for utilization of this acid is to use it as a basis for preparing estersulfonate, a preparation for the control of phytophagous mites. This preparation has been widely tested in USSR agriculture, and the organization of its industrial output is the first problem for the workers of the chemical industry. Other products which are needed for national economy can be derived from parachlorobenzolsulfoacid (ionexchange resins, medicinal preparations, disinfectants, and so on).

Achieving an increase in the concentration of the basic isomer in technical DDT is a very important problem, because it will allow to put out for the use of agricultural economy preparations which are convenient to use--moistened powders. Utilization of such preparations in a form of water suspensions is especially valuable for the control of fruit tree pests. A considerable expansion in the production of concentrated mineral oil emulsions of DDT and an increase of DDT contents in them is also an urgent problem; this will make it possible to improve the quality of the product and reduce the amount of needed tare.

One of the interesting new forms of DDT is a dust with a partial substitution of the filler with ground sulfur, which is especially important for the use on cotton, as this allows to simultaneously control the phytophagous mites. An addition of thiophos to this dust makes it

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a sufficiently general-purpose preparation for the control of all forms of cotton pests.

Scientific workers must continue their research for finding new analogues of DDT which will be as toxic to the insects, but less harmful to warmblooded animals (during systematic treatments of fodders by DDT the poison can accumulate in cows' milk).

Hexachloran (hexachlorocyclohexane) is an equally important insecticide; its production is rising steadily.

Technical hexachloran, which is produced by industry, contains 10-11% of basic toxic element γ-hexachlorocyclohexane. At the same time methods are known which will allow to increase the content of γ-isomer in the product. To these methods pertain utilization of various catalizing additions during the process of chlorination, change in the intensity of lighting, speed and temperature of chlorination, (Begin p. 8) and so on, with the aim of increasing the discharge of γ-isomer during synthesis, as well as conversion of α-isomer, whose contents in technical hexachloran are about 70%, into the toxic γ-isomer. Thus, during the process of synthesis it is possible to obtain a product with a content of 15-17% of γ-isomer.

It is necessary to work out and introduce into production such a system, which would guarantee a maximum content of γ-isomer in the product of synthesis.

Enrichment of products of synthesis by γ-isomer by way of extraction with the aid of a solvent allows to increase the content of γ-hexachlorocyclohexane up to 70-90%, and gives a possibility to obtain a practically pure γ-hexachlorocyclohexane.

At the same time the non-toxic isomers are utilized for obtaining

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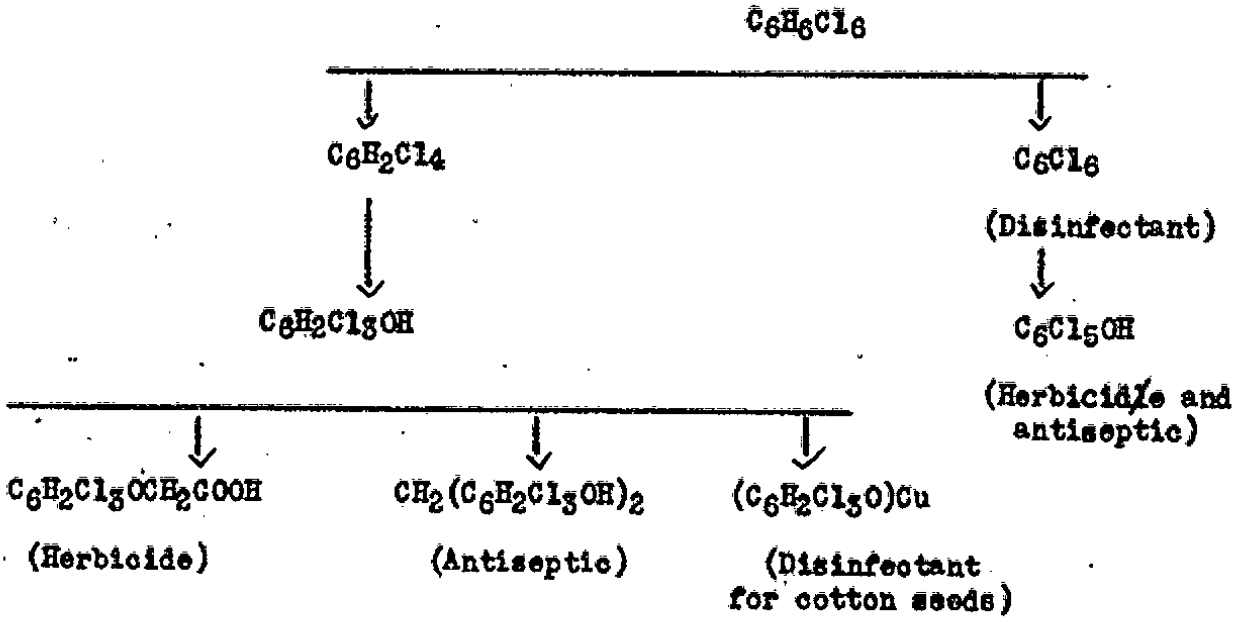
other useful products, particularly such chemical preparations for plant protection, as hexachlorobenzol, pentachlorophenol, 2.4.5-trichlorophenoxyacetic acid, 2.4.5-trichlorophenolate of copper, and others. Basic directions for utilization of non-toxic isomers of hexachlorocyclohexane can be represented by the following scheme:



Introduction into the industry of methods of hexachloran synthesis with a heightened content of γ-isomer will allow to sharply increase the output of a useful product on the same production areas and to improve the economical indicators of work of the shops, producing hexachloran.

It is quite important to expedite into the workshops, occupied with the enrichment of the technical product by γ-isomer, the introduction of utilization of a method of extraction, taking as a basis hexachloran, which is high in γ-isomer percentage, it is possible to start an output of a combined disinfectant--~~xxxxxxx~~ mercurin; its use will allow to simultaneously control both the diseases and the pests of plants. One should note the especially good results which are obtained from the use

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of mercurin for the disinfection of corn seeds. In this case the corn sprouts are protected not only from diseases, but from damage by larvae of click beetles.

Increase of content of the active element (γ-isomer) in the technical product will considerably decrease the volume of transport of ballast materials. Besides that, the unpleasant odor which is characteristic to technical hexachloran is almost entirely removed. That is why it is essential that the industry in the nearest future change over to the output of only the enriched hexachloran with a content of γ-isomer not less than 65-70% with a following change of production to a product containing 90% or more of γ-isomer.

It is necessary to decide many problems in the shortest possible time in connection with this--problems which are linked to the improvement of active productions of hexachloran and guarantee a proper technological shaping of crystallization stages, of discharge, and others, modernization of the lighting apparatus during the chlorination stage, curtailment of raw material norms, and improvement of labor conditions in hexachloran workshops. Moreover, work must be continued on studies and tests of other methods of synthesis of hexachlorocyclohexane, particularly about the catalytical dark chlorination of benzol in the presence of hypochlorites and unsaturated compounds.

For an effective utilization of means for the protection of plants of vast, and often decisive, importance is the proper choice of forms of utilization of preparations.

Such wide spread preparations as DDT and hexachloran, are usually put out in the form of dusts or concentrated emulsions, which differ in

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the content of the basic and the supplementary substances (fillers, emulsifiers, and so on). Hitherto these emulsions were not being produced in sufficient quantities and a growth in the production of emulsions is a very important problem. Expansion in the output of mineral oil emulsions of hexachloran is especially important for the control of beet weevil. In order to raise the content of active element and reduction of outlay of the preparation, an organization of production of concentrated emulsion-pastes is desirable. Such pastes, when diluted locally with water to the proper concentration of the active ingredient, comprise emulsions and suspensions, very convenient in work and sufficiently stable. Output of such preparations gives also a substantial economy in transportation.

It should be noted that, notwithstanding a systematic growth in the production of dusts, the rate of automatization and of mechanization of labor-consuming works remains quite insufficient. Among the immediate problems which face the industrial workers who produce the dusts, one should point to the mechanization of the feeding of raw materials, of loading and packing of the finished product, to the hermetization of the apparatus for reducing losses in the dust and for the improvement of working conditions, as well as to the increase of grinding equipment and to the automatization of the process of dusts' production.

Simultaneously with this it is necessary to more widely utilize the abundant and local fillers for the production of dusts. A partial substitution of talcum by ashes from boiler electrostations has considerably decreased the cost of dusts. Further investigations in this

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respect should be conducted more energetically than heretofore. This will cheapen the dusts still more and will reduce considerably the transportation costs of fillers.

Side by side with the widening and improvement of active productions of DDT, of hexachloran, granosan, of various dusts, emulsions, and so on, before the chemical industry stands a problem of organizing production of new poison-chemicals which are needed for our agriculture.

From among chlorine containing preparations, one should first of all name chlorten-insecticide and (Begin p. 4) acaricide for fruit crops, and cotton, as well as for the control of beet weevil; it is a product of chlorination of bornyl chloride, which is obtained by hydrochlorination of the pinene fraction of turpentine; also the trichlorophenolate of copper--a disinfectant for cotton seeds for the control of gummosis, which is obtained from tetrachlorobenzol and which is substituting the mercuric disinfectant--granosan, should be named.

Much importance is given to the organization of production of phosphorus organic chemicals (preparations for plant protection), representing insecticides and acaricides, especially effective against the bug of harmful eurygaster, for the control of pests of fruit crops, cotton, citrus trees, and so on. To this group of preparations belongs thiophos (O.O-diethyl-O.4-nitrophenylthiophosphate), whose production abroad has achieved considerable size and which is widely used for the control of a mite (Tetranychus urticae Koch.) and of other sucking insects, for the control of woolly scale insects (Coccidae) which attack citrus plants, and others.

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"Karbofos" (0.0-dimethyl-S-dicarbethoxyethyldithiophosphate) can be used for the same purposes, and so can "metafos" be used (0.0-dimethyl-0.4-nitrophenylthiophosphate). The most prompt organization of production of karbofos is particularly needed because of the growth in numbers of individual orchards, and this preparation is only a little toxic to men and animals and can be extensively used by horticulturists.

From among the phosphorus organic insecticides of great interest is a group of substances known under the name of insecticides of systemic (intra-plant) action. Treatment with these preparations makes the plants poisonous for a long time to the sucking insects and decreases the number of treatments of plants by insecticides. Thus, for instance, in order to exterminate the aphids and mites (Tetranychus urticae Koch.), instead of six treatments of cotton with anabasinesulfate or nicotinesulfate one or two treatments with "merkaptofos" (0.0-diethyl -β-ethylmercaptoethyl-thiophosphate) or with octamethyl (octamethyltetramide of pyrophosphoric acid) are needed. One should point out, though, that on account of high toxicity of phosphorus organic chemicals to warmblooded animals, their production, their reprocessing into dusts and utilization in agriculture call for precautionary measures.

It is necessary to intensify production and improve the quality of the most important inorganic insecticides--zinc phosphide, barium chloride, colloidal sulfur, sodium fluosilicate. Colloidal sulfur must be provided with such wrappings that no drying out or caking of the preparation occurs. Also in the nearest future there should be organized the production of preparations for dusting and spraying on the basis of copper oxychloride--a fungicide for green plants, having lesser phytocidicity and more convenient in use than Bordeaux mixture. Introduction of copper oxychloride

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into the practice of agricultural production makes a great saving on copper.

Widening of the production of the sodium salt of 2.4-dichlorophenoxyacetic acid (2.4-D), a preparation for the control of weeds, is of particular importance. Side by side with this it is necessary to organize the obtaining of esters of 2.4-dichlorophenoxyacetic acid and of its salts with amines, which will allow control of such forms of weeds as pink smartweed, ragweed, and others which cannot be eradicated by sodium salt 2.4-D. Moreover some of the esters and salts are much more effective--and the norms of their outlay is 2.5-3 times smaller than of sodium salt.

The cited preparations, of course, do not exhaust the full nomenclature of chemical agents for plant protection, with which our chemical industry should provide our agriculture.

The necessity for expanding the assortment of chemical preparations is also dictated by the adjustment of insects to certain types of insecticides; for this reason it is necessary periodically to change the type of chemical preparations which are being used.

The scientific-research institutes are faced with a problem of finding new, effective, more general-purpose and cheap mediums--first of all for the control of the most persistent and abundant pests: the Colorado beetle, the bug of the harmful eurygaster, San Jose scale, phytophagous mites, beet Curculionidae, phylloxera, as well as for control of plant diseases--potato canker, citrus mal secco, and cotton gummosis.

A separate and responsible problem is that of finding new herbicides, defoliants, non-mercuric disinfectants, effective plant-growth substances,

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fungicides which would not require an outlay of scarce metals, and so on.

It is necessary to study deeply the appearance of regularities which determine the connection among the composition, the structure and the physiological activity of chemical compounds, which are used for the protection of plants, and also of the colloido-chemical bases of rational use of the preparations.

The most serious attention must be given to increase of experimental work and to the improvement of technological treatment of processes in obtaining agricultural poison-chemicals.

It is necessary to note, that an absence of a proper base (particularly in NIUIF [Scientific Research Institute of Fertilizers and Insecto-fungicides im. Ya. V. Samoylov]) leads to the fact that technological elaboration of preparations which are offered for industrial introduction is not always sufficient; this substantially retards the work of organization of production and impairs the technical and economic indicators of the shop's work. In connection with this an important problem is to organize in a series of enterprises of experiment workshops and of widening the experimental works on the experiment factory of NIUIF.

So as to increase the effectiveness of work of scientific-research organizations which are occupied with problems of production of chemical substances for the protection of plants, at present time many prospective, joint plans have been worked out by some institutions (Begin p. 5) of the Academy of Science of USSR and of allied republics, by the All-Union Academy of Agricultural Sciences, imeni [name] of V. I. Lenin, by Institutes of MKhP and of some other ministries.

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Chemical mediums for the protection of plants are not utilized in agricultural system sufficiently effectively. There are serious deficiencies in the organization of storage facilities for poison-chemicals; the proper distribution system has not been put into effect to serve the regions which are most menaced. In some cases the effectiveness of poison-chemicals is lessened by the absence of the necessary apparatus for dusting or spraying.

Better relations among workers of chemical industry and those in agriculture will help in improving the organization of experiments and introduction of new poison-chemicals, will remove deficiencies in deliveries of chemicals to farmers and in utilization of preparations provided by the chemical industry.

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(In full)
bn/A

Ryshkov, I. G.

Kombinirovannoe opudrivanie semian ozimykh granozanom i geksakhloranom - reserv povysheniia urozhainosti.

Combination dusting of the seed of winter grain with granosan and benzene hexachloride - a reserve to increase productivity.

Zemledelie, vol. 3, no. 7, pp. 92-94, July 1955. 20:244

(In Russian)

A 738

Within the complexity of measures ensuring high and stable yields the protection of young crops against pests and diseases is of great importance. With this objective the Stavropol State Selection Station in 1950-1954 dusted seed with a combination of granosan and benzene hexachloride [geksakhloran].

Experiments have demonstrated that combination dusting with granosan and benzene hexachloride disinfects the seed of winter wheat and barley against stinking smut [Tilletia tritici], covered smut [Ustilago hordei], Fusarium and other fungus diseases. Dusted seed are not attacked by false wireworms or wireworms.

Upon dusting winter wheat with granosan at the rate of 1 kg per ton of seed and benzene hexachloride (4 kg per ton), field germination of seed, compared with those undusted, increased by 7%, the number of spike-bearing stems increased by 14%, plant weight at the stage of tillering rose 10.6%, and yield increased by 4.5 centners per ha of grain. Increasing the dose of granosan up to 2 kg per ton of seed and benzene hexachloride up to 10 kg per ton boosted field germination by only 2%, the number of spike bearing stems by 3%, plant weight at the stage of

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tillering by 9%, yield by 3.5 centners. The yield of winter barley, the seed of which had been dusted with increased doses of the preparation, rose by 3 centners, while upon treatment with the usual doses it rose 4.5 centners per ha. Thus, a 10 kg dose of 12% benzene hexachloride dust recommended for combination dusting in the central belt of the Soviet Union proved less effective under our conditions than a 4 kg dose.

A better dose of granosan in combined dusting is 1 kg per ton of wheat seed, 1.5 kg per ton of barley and 2 kg per ton of oats.

The experiments conducted by the Stavropol State Selection Station have confirmed the high effectiveness of combination dusting of the seed of grain crops with granosan and benzene hexachloride in the doses recommended. Thus, a four year average yield of the winter wheat Hybrid 343 planted from seed dusted with the preparations in the doses indicated comprised 25.6 centners, and from undusted seed - 21.5 centners per ha (increase of 4.1 c), of the winter barley Mutans 7--18.9 centners and 13.9 centners respectively (increase of 5 c), of the spring wheat Stavropol'skaia 2260--14 centners and 11 centners (increase of 3 c), of the spring barley Kruglik 188/49--19.6 and 16.4 centners (increase of 3.2 c).

In the fall of 1954, upon sowing seed of the winter wheat Hybrid 345 dusted by the combination method, 1 square meter produced an average of 389 plants, yet upon sowing undusted seed it produced 330 plants; [Begin p. 98] consequently, field germination increases by 17.9%, when seeds are dusted with granosan and benzene hexachloride.

Plants grown from dusted seed were more vigorous and possessed greater resistance to diseases, rust infection in the milk stage in the winter wheat Voroshilovskaia decreased by 15% and in the Mutans 7

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barley by 12%.

According to three-year data the fullness of grain obtained from dusted seed was 5 gr (1.2%) higher in winter wheat and winter barley than in control crops, in spring wheat it was 1.3 gr (1.3%), in spring barley by 1.8 gr (4.2%) lower.

The positive influence of combination dusting of seed upon plant growth and development is characterized by the increased weight of plants derived from dusted seed. Thus, in our experiments, the weight of plants of the winter wheat Hybrid 343 increased during the tillering stage by 16.6%, during the booting phase by 62%, and in the phase of heading by 5.4%.

Experiments demonstrate that an accumulation of dry substance in plants obtained from dusted seed surpassed that in control crops by 7.9%.

It must be noted that in combination dusting of seed the magnitude of yield increased under Stavropol conditions depends on soil moisture. In years with sufficient precipitation during the vegetative period (1952) the biggest increase in yield was observed in winter wheat--4.3 c per ha, and in winter barley--6.3 centners.

In dry years the increase in yield is considerably lower, which can be explained by the fact that microbiological processes are retarded in dry soil. Although benzene hexachloride is not a fertilizer it, nonetheless, changes the food regime and increases soil fertility[1] by increasing the composition of useful pectin-fermenting and pectin-decomposing microorganisms in the soil and by destroying in it injurious insects.

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[1] A. A. Bogdarina. Influence of benzene hexachloride upon the microbiological processes in the soil and upon the growth of wheat. Trudy XX Plenuma Sektsii Zashchity Sel'skokhoziaistvennykh Rastenii. Sel'khozgiz, 1952.

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The technique of combination dusting of seed is very simple. Seeds are dusted evenly with granosan in the doses indicated in seed disinfecting machines (PU-1, AB-2, PSP-0.5), then, to be treated with a 12% benzene hexachloride dust, they are let through a machine a second time.

It should be noted that in dusting seed with a mixture of these preparations the effectiveness of granosan is somewhat diminished.

The keeping duration of seed treated by the combination method depends on moisture, the physiological maturity of the seed, and on storage conditions. As a membranous [plenchatyi] crop, barley should be treated 6-7 days before it is seeded at an air temperature of 14° C and above. In the spring when temperatures are lower, disinfection of seed with conditional [konditsionnoi] moisture may be accomplished 10-14 days before seeding. When storage of treated seed lasts longer, then a decrease in germination is observed. In our experiment, in seed of wheat which had undergone combination dusting and was stored over 20 days at an air temperature of 18-20° C, germination in the separate varieties dropped by 1-5%, as compared with control plants.

In the Stavropol Territory, combination dusting of seed during the pre-seeding preparation of the seed of grain crops should be made compulsory. In arid regions this practice is a means of safeguarding seed against injuries by the false wireworm. In case it becomes necessary to sow winter wheat in soil that is badly infested by false wireworms, then it is desireable to increase the dose of 12% benzene hexachloride dust up to 10 kg per ton of seed.

At the present time mercuran [merkuran] is being released; this preparation contains granosan and benzene hexachloride, and its application will facilitate seed treatment considerably.

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In recent years combination dusting of seed has been used widely on many kolkhozes of the Stavropol Territory. In the year 1954 seed of winter wheat treated by the combination method were sown over the entire seeding area of this crop on the kolkhoz imeni Zhdanov, Novo-Aleksandrov MTS (3140 ha), on the kolkhoz imeni Lenin, Suvorov MTS (2500 ha) and on many other kolkhozes.

Combination dusting is a highly effective method and should be adapted extensively to agricultural production. An expenditure of no more than 1.5--2 rubles per hectare for the preparations and the process of treatment will secure 2-4 centners of additional grain.

* * *

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Translation A-739
(In full)
bn/A

Rusakova, A. A., and Raskin, S. E.

Preparat TMTD dlia protravlivaniia semennykh korneplodov markovi.

[TMTD preparation for treatment of seed carrot root crops.]

Zemledelie, vol. 2, no. 8, pp. 39-43, Aug. 1954. 20 Z44

(In Russian)

A 739

In the year 1952, we conducted tests of a 50% preparation of tetramethylthiuramdisulfide (TMTD) for the control of various rots of seed carrot root crops while they are in storage, and also after they have been planted in the ground, on the "Oktiabr'skaia revoliutsiia" kolkhoz, Ramensk District, Moscow Region, and in 1952 and 1953 on the imeni Voroshilov kolkhoz, Bronnits District.

In one treatment, spring or fall, 6-7 gr of a 50% TMTD preparation were used on 1 kg of carrot root crops; however, in the case of a double treatment (spring and fall), the consumption rate of the preparation in the spring treatment was reduced to 3--4 gr per kg of carrot root crops.

In the fall treatment the carrots were carefully sorted and only the healthy roots were treated. Treatment of carrots was carried out with the aid of gauze bags as they were put in storage.

Fig. 1. Seed carrots treated with a 50% TMTD preparation on the kolkhoz imeni Voroshilov, Bronnits District, Moscow Region, in 1952.

[Begin p. 40]

The soil surface of the place where piles are arranged, or the bottom ~~of a tren~~

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of a trench and also its side walls were preliminarily, carefully dusted with the preparation. The carrots were stored in rows and sprayed from above; then they were covered with sand so the roots would not come in contact with each other; the upper layer of the sand was also dusted with the preparation and the second row of carrots which was spread on top of it was dusted in the same manner. In this sequence all rows of the pile and the trench were treated.

If carrots are kept in a vegetable storage room, then treatment can be effected not only during the process of storing, but also in open air by utilizing a wooden trough (1.6 x 1m). In such a case the treated carrots are stored in rows and only the sand which covers the rows of carrots is dusted with the preparation.

The seed carrot root crops (treated as well as untreated) were carefully sorted at the end of winter storage, and the obviously rotten roots were separated from the healthy ones. Spoilage of carrot root crops from all types of rot for the winter of 1951/52 and 1952/53 is shown in table 1.

Table 1.

Carrot variety	Storage place	Preparation	Number of roots stored	Spoilage of carrot roots (in %)		
				Due to black rot and phomosis	Due to white rot	Total
		"Oktiabr'skaia Revoliutsiia" Kolkhoz				
Gribovskaia	Vegetable storage room	Control	3524	33	3.8	36.8
		50% TMTD	3657	16	4.5	20.5
		Kolkhoz imeni Voroshilov				
Nantskaia	Trench	Control	3704	16	4.8	22.3
		50% TMTD	3616	12	0.5	12.5
		Control	11440	-	-	77.3
		50% TMTD	65420	-	-	23.4

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Note. The somewhat worse white rot infection of the Gribovskaia carrot variety stored in a stack that had been treated with a 50% TMTD preparation (4.8%), compared to the control stack (3.8%), can be explained by the circumstance that this stack adjoined the outside wall of the vegetable storage room and was sometimes exposed to freezing and sometimes to thawing which, naturally, contributed toward the infection of tissues weakened by white rot.

The table shows that spoilage of carrots treated with a 50% TMTD preparation was considerably lower than that of controls.

Roots selected in the spring after winter storage were treated with a 50% TMTD preparation before they were planted in the ground; treatments consisted of thorough dusting and were performed in the open air in a wooden trough.

Spoiled seed roots were counted in the field for the length of the vegetative season.

The effect of treating seed carrot root crops with a 50% TMTD preparation upon spoilage of roots in the field and upon the yield of seed is shown in table 2.

Table 2 discloses that the largest percentage of spoiled carrot roots (69 and 80) for the vegetative season was observed on plots planted to untreated roots. When roots were treated with a 50% preparation of TMTD, [Begin p. 41] the percentage of seed root spoilage was considerably lower (29--32 and 59--62).

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Table 2.

Preparation	Time of treatment	Number of roots planted (Apr. 29)	Seed root spoilage in %		Yield of seed (in kg/ha)	Number of roots planted (May 5)	Seed root spoilage in %		Yield of seed (in kg/ha)
			In budding season (Apr. 30)	For vegetative season			In budding season (Jl.10)	For vegetative season	
"Oktiabr'skaia Revolutsiia" kolkhoz - 1952									Kolkhoz imeni Voroshilov - 1952
Controls.....	-	1106	44	69	87	1049	68	80	70
50% TMTD.....Spring and fall		2096	22	31	160	1876	25	38	193
Same..... Fall		474	23	29	148	991	27	39	200
" "..... Spring		952	22	32	153	979	45	62	157
			1953						
Control.....	-	-	-	-	-	1146	-	48.3	160
50% TMTD.....	Fall Spring	-	-	-	-	3103	-	12.9	600

Observations have shown that a double treatment of carrot roots (spring and fall) produces better results. One fall treatment is more effective than one spring treatment. A double treatment (in fall and an additional one in spring) should be applied chiefly when the loss of carrots is considerable after winter storage.

This was corroborated by the 1953 experiment when winter spoilage of controls was 77.3% against 23.4% of roots treated with a 50% TMTD preparation, and in the field the loss of plants was 48.3 and 12.9% respectively at a 600 kg yield of seed in the variation treated with GMTD [tr. note: probably TMTD], against 160 kg per ha of control plants.

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The influence of disinfection of carrot seed roots with a 50% TMTD preparation upon the development and degree of preservation of carrot seed plants during the period of full flowering is shown on figures 1,2,3, and 4.

On the basis of the above statement it can be said that the application of a 50% TMTD preparation as a dry disinfectant of carrot seed plants has proved its worth and has produced the best results when treatment was applied in the fall, and also when the fall treatment was supplemented by another one in the spring.

The advantage of this preparation over NIUIF-1 [preparation of Scientific Institute of Fertilizers and Insectifungicides) is comprised in the fact that it can be applied as a dry disinfectant, contains no mercury and equals benzene hexachloride in toxidity.

We have not conducted any special experiments in feeding carrots treated with a 50% TMTD preparation to livestock. However, no harmful effect was observed in chickens when they ate peas treated with a 50% TMTD preparation at the rate of 8 kg per ton of seed.

According to a conclusion of the State Sanitary Inspection [Gossaninspektsii] of the USSR, agricultural plants sprinkled with a 2% suspension of a 50% TMTD preparation [Begin p. 43] must not be fed to cattle sooner than 20-30 days after the treatment.

Safety measures for poisonous chemicals specified in the instruction of the Ministry of Agriculture, USSR, for storing, release, transportation, and for the use of poisonous chemicals in the control of pests and diseases of agricultural plants on kolkhozes and sovkhozes, must be observed when work is done with the 50% TMTD preparation.

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Fig. 2. Untreated carrot seedlings on the kolkhoz imeni Voroshilov, Bronnitsy District, Moscow Region, in 1952.

Fig. 3. Carrot seedlings treated with 50% TMTD preparation on the "Oktiabr'skaia revoliutsiia" kolkhoz, Ramensk District, Moscow Region, in 1952.

Fig. 4. Untreated carrot seedlings on the "Oktiabr'skaia revoliutsiia" kolkhoz, Ramensk District, Moscow Region, in 1952.

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Translation A-740
(In full)
bn/M

Mkhitarian, M. A.

Puti vyvedeniia sortov pshenitsy ustoichevykh k rzhavchine.

[Ways of developing wheat varieties resistant to rust.]

Agrobiologiia, no. 1, p.100-106, Jan./Feb. 1955. 20 Ag822

(In Russian)

The mountainous situation of Armenia--sharply expressed vertical zonality and various soil-climatic conditions--contribute to the increase of variability and to processes of formation of wheat in natural conditions. Valuable qualities of regionalized varieties--yielding capacity, resistance to disease, capacity to retain ripe grains until harvested, and so on--often become worse under different agro-ecological conditions. That is the reason why there is a problem before selectioners and researchers, working in the field of plant protection, to develop steady varieties of wheat for every natural zone of Armenia.

A 740

Utilizing intraspecific crossing and individual selection, the scientific workers of the Academy of Science of Armenian SSR have developed varieties of winter wheat such as Egvardi 4, Artashati 42, Armianka, and others, regionalized within low-lying, foot hill and mountainous regions of the republic. Other varieties were also developed which are now being tested. From among them the most promising are winter wheat Ferrugineum 22 and spring wheat Vardenik (persikum). But these varieties do not give in all mountainous regions of the republic resistant and high yields. That is why the problem of providing all the various mountainous and foot hill

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regions of the Armenian SSR with high-yielding varieties of spring and winter wheat is not yet solved.

Researches, which were conducted by the Section for Plant Protection of the Academy of Science of Armenian SSR, have shown that resistance to disease, especially to rust, and the yielding capacity in the newly developed and regionalized variety often decrease with time. That is why the Section had a problem in studying conditions which will assist in retaining the resistance to rust in regionalized varieties, and at the same time to develop new, comparatively resistant, high-yielding varieties.

By sowing on different dates in zones, which are situated on different heights above sea-level, and by selection from the newly developed forms, which were resistant to rust, which did not shed the ripe grain, which were early-ripening, lodging-resistant and highly-yielding, it became possible to develop in mountainous regions of Armenian SSR from seeds of local Martuninsky reproduction of Ukrainka variety, a new, comparatively resistant to rust, high-yielding variety of winter wheat--Martuk, which was handed over to a government commission for variety tests.

It is especially important for this zone to develop resistant and high-yielding varieties of spring wheat, because the regionalized varieties of spring wheat here give almost two times smaller crops than winter wheat. Notwithstanding this, in mountainous regions of Armenian SSR spring wheat is planted on considerable areas. (Begin p. 101)

By sowing early in spring on different dates (beginning with March) of unripe seeds of winter wheat Aitiagadzh, after 6 years they succeeded

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in transforming this winter form into spring, and by a further selection from newly developed, resistant to rust, lodging-resistant forms, to develop a comparatively resistant and fruitful variety Oziar (winter wheat, which was transformed into spring wheat). This variety was also turned over for variety tests. Other forms were also obtained from soft, hard and ramose wheat, which are tested now. Let us give results of preliminary variety tests of varieties Martuk and Oziar for three years (table 1).

Table 1.

Attack by rust and the mean yield of wheat varieties

Variety	Form of rust	Degree of infection of plants by rust (in points)	Yield (in c/ha) 1950	1951	1952	Mean for three years
		Akhta. Experimental Field				
Winter						
Martuk	Yellow	0.5	-	-	-	-
	Brown	0.1	42.5	23.8	31.9	32.7
	Stem	0.5				
Karmir Sifaat (local regionalized)	Yellow	3.0	-	-	-	-
	Brown	0.5	40.5	21.6	30.1	30.7
	Stem	0.5				
Ukrainka (regionalized)	Yellow	2.0	-	-	-	-
	Brown	0.5	35.1	21.0	29.6	28.5
	Stem	1.5				
		Kirovakan. Experimental Field				
Spring						
Oziar	Yellow	0.5	-	-	-	-
	Brown	0.6	27.7	31.5	28.8	29.3
	Stem	0.6				
Erinatsum (local regionalized)	Yellow	2.5	-	-	-	-
	Brown	1.0	8.4	12.7	20.1	13.7
	Stem	0.5				

Footnote. 0.1 of point--single spots of rust; 0.5 of point--10-15%

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of surface of green parts of plants is covered by rust spots; 1 point--15-25%; 1.5 point--25-40%; 2 points--40-55%; 2.5 points--55-65%; 3 points--65-75%; 3.5 points--75-85%.

As seen from table 1, Martuk and Oziar were attacked by yellow rust much less than the regionalized varieties Ukrainka and Erinatseum.

The average yield of Martuk was 2 c more than the yield of the variety Karmir Sifaat and by 4.2 c more than the yield of Ukrainka. The yield of Oziar is twice higher than of the local regionalized variety of spring wheat Erinatseum.

As Oziar, so also Martuk belong to soft wheat of the variety Eritrospermum. In the grain of Martuk variety there is 18.0% of raw protein, and in Oziar variety 19.1%. In morphological properties it differs considerably from initial varieties. (Begin p. 102)

Conditions, which assist in the increase of wheat resistance to rust.

Capacity of resistance to disease in wheat depends to a large degree on climatic conditions and on agrotechnical cultivation. One and the same variety planted in different zones and on different dates is not equally affected by disease, especially by rust. Both resistant, and vice versa, forms which are easily subjected to disease, can be formed in the course of development of varieties under changed conditions.

By changing the conditions of cultivation, it is possible to give a certain definite course to the process of mutability and form development, and, in particular, to increase the resistance to diseases.

Results of experiments, which were conducted in regions of Armenian SSR situated at different heights above sea-level, have shown that by moving wheat varieties from mountainous zones (average summer temperature 15-18°) into the lowland dry zone (Ararat plain; mean summer tempera-

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ture 18-25°) their resistance increases both to rust as well as to smut. Thus, for instance, winter wheat of Ukrainka variety, which was planted in the lowland zone (height of 1000 m) with seeds brought from mountainous zone (height of 2000 m) was infected by yellow and stem rust very weakly (to 0.1 point) during the first year of vegetation.

This same variety, planted with seeds obtained in the lowland zone was infected much stronger: to 1 point by yellow and stem rust, and by brown rust--to 0.5 point.

When transferring wheat varieties from lowland dry regions into the mountainous zone the resistance of all varieties to rust and smut is lowered.

Even the highly resistant spring wheat Timofeevi, which was cultivated for several years in the lowland zone and planted on September 25 at the height of 1800 m above sea-level and April 28 at the height of 2000 m, has partly lost its resistance and was infected by rust, although weakly (0.1 point).

Lessening of wheat's resistance must be explained by the fact that here, in conditions of comparatively low temperature, the growth of plants is slowed down and the length of vegetation and of development period is prolonged, in consequence of which, probably, the contents of protein substances, which are easily appropriated by parasites, are increased.

Some authors link together the resistance or receptivity of wheat varieties to rust with the presence or absence of biological races or biotypes of rusts. That is why, if one or another variety of wheat in a certain region is not infected, it is supposed that there are no cor-

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responding races or biotypes of rust which infect these varieties. According to our judgment, one cannot pinion the resistance of varieties to only the existence of biological races and biotypes of wheat.

Timofeevi wheat, which was planted in humid regions of forest-steppe zone of Armenian SSR before winter (October 25) or in spring (April 5), was not infected by any forms of rust, but the one planted in summer (June 16), that is at an uncommon date, was infected with yellow, brown and stem rust to 0.1--0.5 point. Consequently, having planted Timofeevi wheat in regions of humid forest-steppe zone on October 25 or April 4 one can conclude that in natural conditions there were no biological races of rust forms which infect this type of wheat; while if one sows this same wheat in the same region and even on the same (Begin p. 103) section on June 16, then the conclusion will be reversed: one should recognize that biorraces which infect Timofeevi wheat are present there (table 2).

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Table 2.

Infection of wheat by rust (in points) depending on the time of planting.

Variety	Species of rust	Time of planting		
		15-25 August	10-25 September	10-25 October
		Infection by rust		
Kirovakan. Experimental Field.				
Ukrainka, from seeds of local reproduction	Yellow	0.5	1.0	1.0
	Brown	0.5	0.5	0.5
	Stem	2.0	1.5	2.5
Armianka variety, cultivated for 5 years in Stepanavans	Yellow	2.0	1.5	2.0
	Brown	0.5	0.1	0.5
	Stem	1.0	0.5	1.5
Altiagadsh local	Yellow	2.5	1.5	2.5
	Brown	0.5	0.1	0.5
	Stem	1.0	0.5	1.0
Akhta. Experimental Field.				
Karmir Sifaat local	Yellow	3.0	2.0	2.5
	Brown	0.5	0.5	0.5
	Stem	0.5	0.5	1.0
Martuk, cultivated for 5 years in Akhta	Yellow	0.5	0.5	0.5
	Brown	0.1	0.1	0.5
	Stem	0.1	0.5	0.5
Ukrainka, from seeds of local reproduction	Yellow	1.0	1.0	1.5
	Brown	0.5	0.5	0.5
	Stem	1.5	1.0	2.0
Ramose winter wheat, cultivated for 5 years in Erevan	Yellow	3.0	2.5	3.5
	Brown	0.5	0.5	0.1
	Stem	0.1	0.1	0.5
Martuni-Vardenik. Experimental Field				
Karmir Sifaat local	Yellow	3.0	2.0	3.0
	Brown	0.1	0.5	0.5
	Stem	0.1	0.1	0.5
Ukrainka, from seeds of local reproduction	Yellow	1.5	1.0	1.5
	Brown	0.1	0.1	0.5
	Stem	0.5	0.5	1.5

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As we see it, resistance to rust of varieties is connected to actual climatic and agrotechnical conditions of cultivation. Degree of infection depends on resistance, which is developing in a variety under given conditions. One should also take into consideration, that infection of a variety can increase or decrease because, under different conditions of environment, the processes of nutrition and of development of the parasite itself proceed differently.

A change in resistance to rust, which is a physiological property of plants, is accompanied by certain morphological (Begin p. 104) characteristics. From Timofeevi wheat, which is sown in June (an unusual date) in himid mountainous regions, develop slightly downy and light green plants, whose resistance to rust is lowered. Resistance of variety Timofeevi, as well as other varieties of spring wheats, is increased if they are planted before winter sets in, or early in spring; in such cases the plants of Timofeevi variety become dark green and more downy.

From seeds of Ukrainka winter wheat, obtained in high mountainous regions (2000-2500 m above sea-level) and sown during the most favorable periods (middle of September) in regions situated on heights 1400-1700 m, forms develop which shed the grains very little, have elongated keels of outside spike lamella; and from seeds of red spiked varieties Altiagadsh and Erinatseum--white spiked forms, less infected by rust, were developed.

By regulating the dates of sowing it is possible to heighten and fix the resistance to rust in spring varieties (Del'fi, Erinatseum, Oziar, and others) when planting before winter starts or early in spring. Let us note also, that a planting of winter wheat on the most

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favorable dates lessens a danger of epiphytic development of rust.

Data about the rate of infection of winter wheat by rust of different forms in mountainous regions are presented in table 2.

From table 2 it appears that winter wheat, which was sown in mountainous regions during the most favorable period--that is from 10 to 25 of September, was infected somewhat more weakly, than one which was planted earlier or later. Winter crops, which were down during the most favorable period, mostly do not get infected by rust in the fall because during tillering (beginning of October) the supply of uredospores in natural conditions is at its minimum. In the next year wheat, hitting favorable conditions for growth and development, ripens on time, is infected by rust comparatively little and gives a high yield.

When winter wheat is planted early, it gets infected (especially by yellow rust) from the late-ripening spring crops and becomes, from year to year, a nidus of rust. Having overwintered inside the leaves of the plant in a mycelium phase, the yellow rust develops during early spring, and at the beginning of milk stage the winter crops become heavily infected by it, owing to which the yield is then considerably lowered.

Winter crops, which are sown later than the favorable dates, do not become infected by rust in the fall, but during the next year rust succeeds to infect the plants during the milk stage because their ripening is delayed.

Resistance of wheat varieties to rust varies, depending on the case which fertilizers, in what combinations and during what stage they were introduced.

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Results of experiments, which were conducted on Kirovskanski and Akhtinski sections on leached, clayey, poor in humus, chernozems, attest to this. Manure was applied to the soil in summer before plowing; phosphorus (superphosphate in powder) and potassium (potassium salt) at the beginning of September, before ploughing again for winter crop planting; nitrogen (ammonium nitrate) at the beginning of May, before harrowing (table 5).

As seen from table 5, the plants were heavier infected by rust in those variants, in which only manure or only nitrogen mineral fertilizer was introduced. Onesided use of nitrogen fertilizers increases the vegetative growth of wheat, retards ripening; the plants (sentence is continued on p. 105 after table 5) (Begin p. 105)

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Table 5.

Influence of norms of various fertilizers on infection of winter and spring wheat by rust (in points)

Variety	← Species of rust	Norms of fertilizers at a rate for 1 ha			
		Manure 55 t	Nitrogen 100 kg	Nitrogen--50 kg Phosphorus--50 kg	Nitrogen--50 kg Phosphorus--100 kg Potassium--25 kg
Kirovakan. Experimental field					
Ukrainka from seeds of local reproduction	Yellow	2.0	2.0	1.5	1.0
	Brown	1.0	0.5	0.5	0.5
	Stem	1.5	2.0	2.0	1.5
Variety Armianka, cultivated for 5 years in Stepanavane	Yellow	2.5	2.5	2.0	1.5
	Brown	0.5	0.5	0.5	0.5
	Stem	1.0	1.0	1.0	0.5
Altiagadsh local	Yellow	3.0	2.5	2.0	1.5
	Brown	0.5	0.5	0.5	0.5
	Stem	0.5	0.5	0.5	0.1
Ramose wheat, cultivated for 5 years in Erevan	Yellow	3.5	3.5	3.0	2.5
	Brown	0.1	0.1	0.5	0.1
	Stem	0.5	0.1	0.1	0.1
Ozlar-spring, cultivated for 5 years in Kirovakan	Yellow	1.0	1.5	0.5	0.5
	Brown	0.5	0.5	0.5	0.1
	Stem	0.5	0.5	0.5	0.5
Akhta. Experimental field					
Karmir Sifaat	Yellow	3.0	3.0	2.5	2.0
	Brown	0.5	0.5	0.5	0.1
	Stem	0.5	0.5	0.1	0.1
Ramose spring wheat, cultivated for 5 years in Moscow	Yellow	3.5	3.0	2.5	2.5
	Brown	0.5	0.5	0.5	0.5
	Stem	0.1	0.5	0.5	0.1
Krinatsum, local variety of spring wheat	Yellow	3.0	2.5	2.0	1.5
	Brown	1.0	0.5	0.5	0.5
	Stem	0.5	0.5	0.1	0.1

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are infected by rust to a larger degree. With a combined use of mineral fertilizers (60 kg of nitrogen, 100 kg of phosphorus, 25 kg of potassium per ha) the resistance of wheat to rust is considerably higher.

For obtaining a high, resistant crop it is important not only to develop new varieties which have new properties, but to grow plants under such conditions which help retention of the new property, also the increase of resistance and the yielding capacity.

Conclusions

1. Resistance of wheat varieties to diseases changes depending on conditions of cultivation.

New, resistant to rust and high-yielding varieties of wheat, can be developed by way of transforming of winter forms into spring, by cultivation of various varieties of wheat in regions, which are situated at (Begin p. 105) different heights above sea-level, by means of sowings on different dates and by selection of newly developed resistant, fruitful forms.

2. Resistance of wheat varieties has increased when seeds from mountainous, cool zones were planted in lowlands, comparatively warm regions. In cases when seeds from lowlands were sown in mountainous zones, the resistance to rust in all varieties was, on the contrary, lowered. That is the reason why seed growing in Armenian SSR should be organized in such a way that seeds from lowlands are not transported into mountainous areas. Every kolkhoz in mountainous regions must be supplied by local wheat seeds, obtained from seed growing sections

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situated comparatively high.

5. Resistance of spring varieties to rust increases and is fixed in the progeny if the sowing is done before winter sets in or in early spring. Resistance and fruitfulness of winter forms is growing if planting is systematically done during the most favorable period.

It is possible to increase resistance to rust in grain crops and their yielding capacity by regulating the dates of sowing and by properly organizing the seed growing.

4. Resistance and yielding capacity of wheat are increased also by use of mineral fertilizers taken in ratio: two parts of phosphorus and 0.5 part of potassium per one part of nitrogen. Pure nitrogen fertilizers decrease resistance to rust.

Section for Plant Protection of the
Academy of Science of Armenian SSR,
town of Erevan

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FOLDER NUMBER	2
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